NEWPORT

OWNERS MANUAL

MP MASTER

MA24694

PENTA P6000
P6XXX PROGRAMMABLE COUNTER / TIMER

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Future options which will be available for the P6000 are:

DC Power Supply
Parallel BCD
Non-Isolated Signal Conditioner
Voltage-to-Frequency Converter
Analog Output

The P6000 is a fully programmable, six-digit counter. It offers 6-digit resolution for totalizing input pulses or for measuring frequency, period, time interval and frequency ratio.

The P6000 offers frequency measurements from .000001 Hz to 7 MHz, time-interval measurements from 200 nanoseconds to 36 days, and totalizing capacity to 6.8×10^{10} .

Auto-range capability of the P6000 allows measurements over a wide dynamic range without sacrificing display resolution.

Programmable gate time provides flexibility in measurement speed and accuracy. Up to 40 readings/sec can be made in all of the modes, and 6-digit resolution can be achieved in frequency or period measurements in less than 1/6 sec.

The P6000 provides either a multiplying or a dividing scale factor ranging from -99999 to 999999 with a choice of six decimal point positions. This allows precise conversion to engineering units with almost any transducer.

The alphanumeric prompts on the 6-digit, 7-segment display make it easy to program with the front panel pushbuttons. A personal computer can also be used to program the P6000 and to monitor the display data via the RS-232 port (standard feature). If desired, the program setup may be stored in nonvolatile memory for recall upon demand or at power-on.

The two setpoints and corresponding alarm outputs of the P6000 make it an ON-OFF Controller for either stand-alone or computer-controlled applications.

The crystal time base of the P6000 may be electronically calibrated, either manually from the front panel or remotely with a personal computer. There are no internal adjustments and the calibration is done without opening the case.

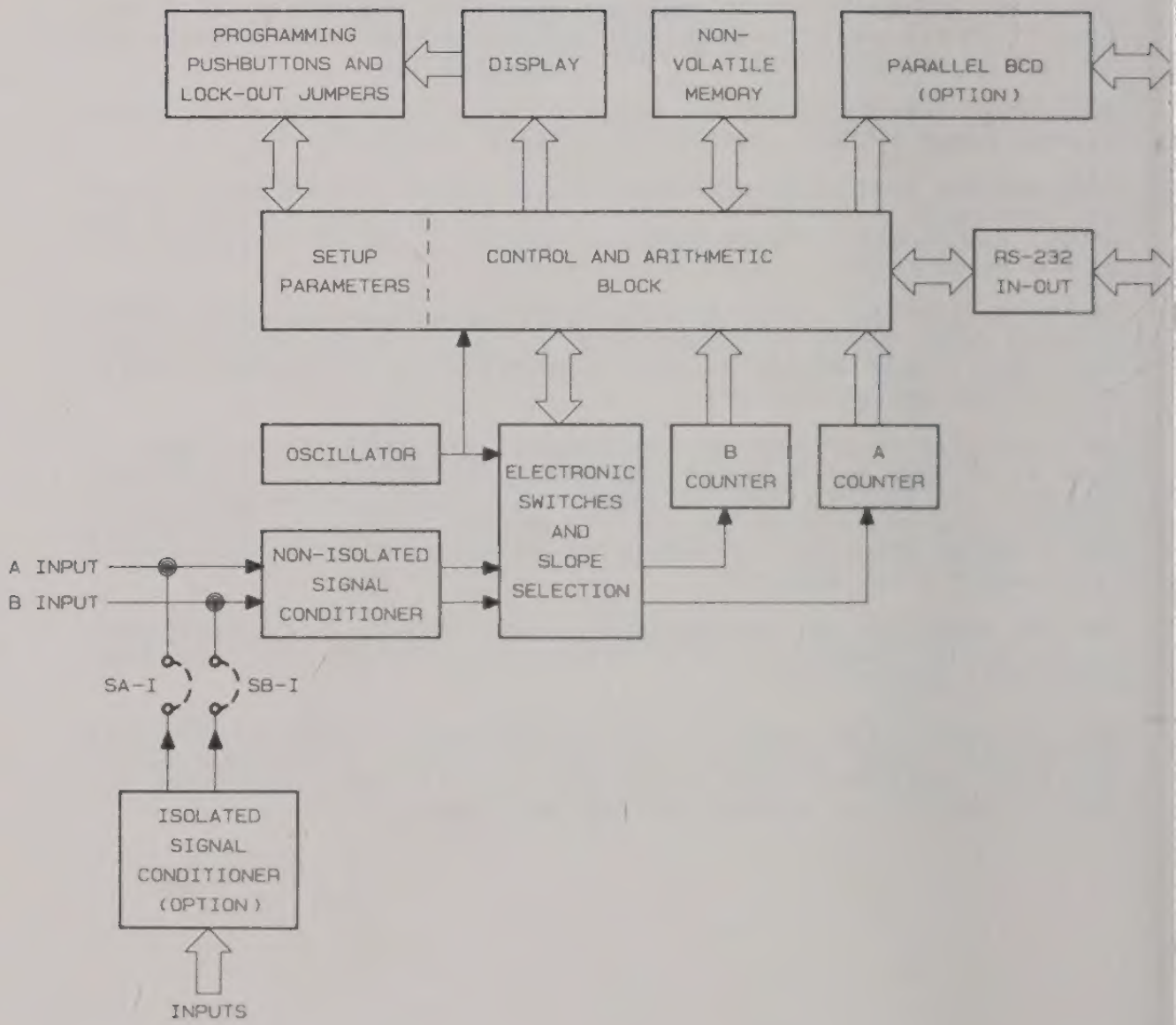


Figure 1-1 The P6000 Block Diagram

2.1 UNPACKING AND INSPECTION

Your P6000 universal panel counter was systematically inspected and tested, then carefully packed before shipment. Unpack the instrument and inspect for shipping damage. If damage exists, do not attempt to operate the unit. Notify the freight carrier immediately.

2 SAFETY CONSIDERATIONS

As delivered from the factory/distributor, this instrument complies with required safety regulations. To prevent electrical or fire hazard and ensure safe operation, please follow the guidelines below:

POWER VOLTAGE - Verify that the instrument is connected for the power voltage rating that will be used. If not, make the required changes as indicated in Section 5.1 of this manual. This instrument is delivered with AC power connection for 115 V in the USA, and for 230 V in Europe (unless the instrument is fitted with DC drive capability).

POWER WIRING - This instrument has no power-on switch; it will be in operation as soon as the power is connected.

Verify that the power cable has the proper ground (earth) wire and that this wire is properly connected to a ground (earth) point. If the panel cutout is a metal enclosure, it must be grounded (earthed).

This instrument is protected according to Class II of the IEC (International Electrotechnical Commission) 348 and the VDE 0411 regulations.

RAIN OR MOISTURE - Do not expose the instrument to condensing moisture.

FUMES AND GASES - Do not operate the instrument in the presence of flammable gases or fumes; such an environment constitutes a definite safety hazard.

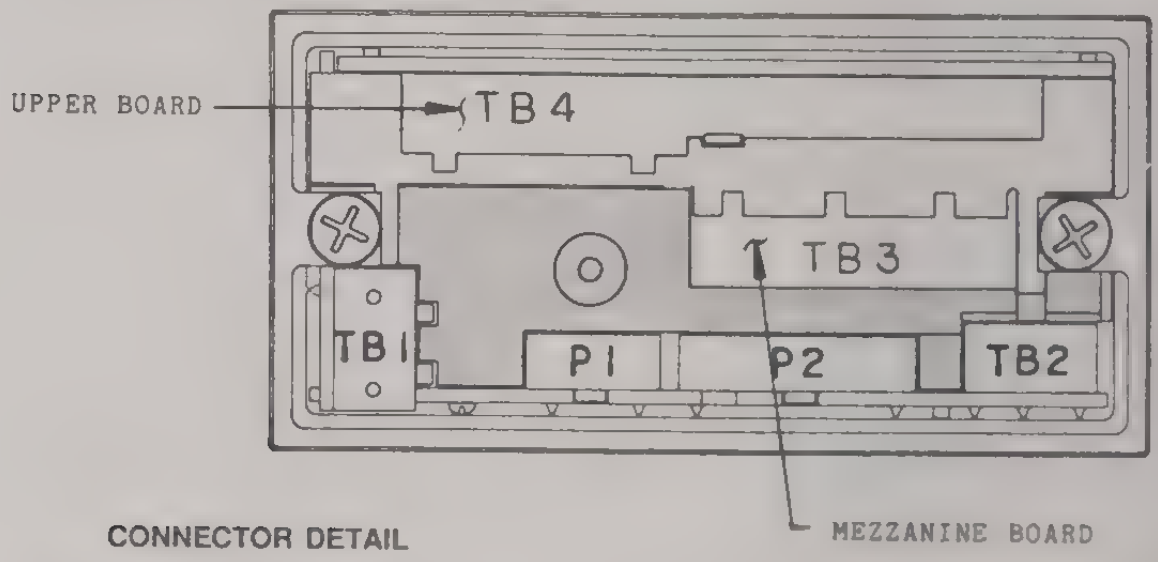
EXERCISE CAUTION - As with any electronic instrument, high voltage may exist when attempting to install, calibrate, or remove parts of the meter.

2.3 TURNING IT ON

WARNING: INCORRECT POWER INPUT CAN DAMAGE YOUR P6000 PANEL COUNTER

Connect the proper line voltage to the power screw terminal (TB1).

When energized, the P6000 will display FrEQ (programmed function) until a reading has been made on the input signal. Then that value will be shown.



CONNECTOR DETAIL

N/C	1	2	N/C
RS232-DATA OUT	3	4	RS232-RTS IN
RS232-DATA IN	5	6	N/C
N/C	7	8	N/C
RS232-GND	9	10	0-20 mA ASCII OUT

P1 (cable connector)

SPARE FF D IN	1	2	SPARE FF RESET IN
SPARE FF Q OUT	3	4	SPARE FF Q OUT
SPARE FF CLK IN	5	6	GND
ALARM HI OUT	7	8	+5V OUT
ALARM LO OUT	9	10	ALARM GO OUT
V+ IN/OUT	11	12	GND
HOLD IN	13	14	BUF IN
BUF OUT	15	16	BLANK ENABLE IN*
GND	17	18	RESET IN
EXT. GATE IN	19	20	DIGIT 6 OUT

*or LINE FREQUENCY OUT

P2 (cable connector)

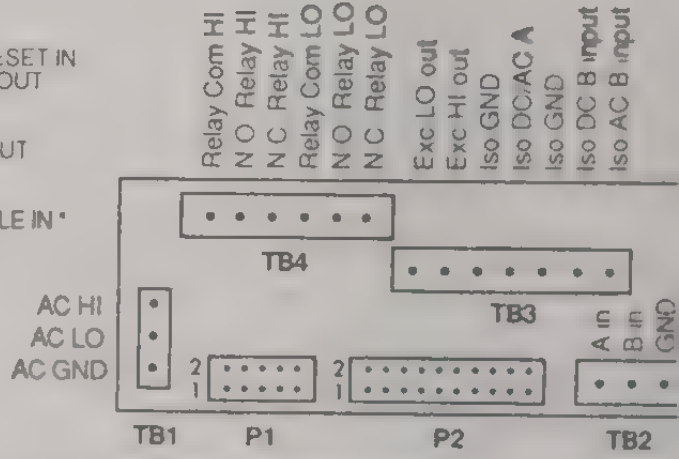


Figure 2-1 P6000 Rear Panel with [illegible] Connectors

To verify the default settings, connect a TTL-compatible square source between pins 1 (SIG HI) and 3 (SIG GND) on the TB2 [illegible] of TB1. If the input is connected to the 400Hz input, the display reads 400.0 ±.03%.

2.4 HOW TO USE PROGRAMMING PUSHBUTTONS

The P6000 provides five pushbuttons labeled RECALL, SET, ADVANCE, ENTER and RECALL. These can be used to display and change setup parameters, similar to a digital clock or watch. The best way to learn the function of the buttons is to experiment with them.

ENTER, ADVANCE, SET, ENTER is the general order used. Each button may be pushed more than once. ENTER steps through the main menu, ADVANCE steps through the sub-menu, SET modifies values or parameters, and ENTER then enters the modification into the active memory.

RECALL BUTTONS - These two buttons reset the meter and read the program stored in nonvolatile memory into the active memory. The previous active program, if different from the stored program, will be lost. The effect is the same as removing power from the meter. To avoid activating RECALL in error, both buttons have to be depressed simultaneously.

ENTER BUTTON - Like ENTER on a computer, this button is used to make menu selections and to enter parameter changes. After entering a parameter change, the meter automatically displays the next menu title or the reading (which follows the last main menu title). The main menu titles appear in this order: Func, SCALE, OFFSEt, rAnGE, SLOPE, SP LO, SP HI, GAtE t, CnFG 1, CnFG 2, CALIb, noStor. One or more of the main menu titles may be skipped, if locked out (bypassed) by jumper installation on pin groups S7 and S8. Definitions of the menu titles are in Appendix B, Glossary of Terms and Symbols.

ADVANCE BUTTON - After a menu title has been selected for display using the ENTER button, pushing the ADVANCE button takes the program into the sub-menu for that item. For instance, pushing ADVANCE after SP HI is displayed shows the setpoint number. Pushing ADVANCE repeatedly changes a flashing location, which corresponds to the parameter which can be modified (a digit or decimal point in this example). The actual modification is made with the SET button, and the modification is entered using the ENTER button. The display then shows the next main menu item (GAtE t in this example).

Pushing the ADVANCE button after Func is displayed shows the current active function: FrEq, PEriod, Ti Int, Fr b/A or totAl. This function will show up flashing, indicating that it can be changed with the SET button.

SET BUTTON - The SET button is used to modify the values or parameters which are flashing. The ENTER button is then used to enter the modification into the active memory.

NOTE: Push the three center pushbuttons simultaneously to reset the counter and start a measurement using the latest setup parameters.

Example 1:

It is desired to program the P6000 to measure the input frequency and display in RPM (instead of Hz). This requires setting the SCALE FACTOR to 60.

DO THIS:	DISPLAY SHOWS:
1. Push ENTER twice.	SCALE
2. Push ADVANCE.	A.SC or A/SC Corresponding to a multiplying or a dividing scale factor.
3. If A/SC is displayed, change it to A.SC by pushing the SET button.	A.SC
4. Push ADVANCE.	1.00000 with most-significant-digit flashing. This is the current scale factor value.
5. Push SET seven times. This sets the most-significant-digit to 6.	X.00000, 1.00000, 2.00000, 3.00000, 4.00000, 5.00000, 6.00000 (X denotes flashing)
6. Push ADVANCE six times. This selects the decimal point (flashing).	6.X0000, 6.0X000, 6.00X00, 6.000X0, 6.0000X, 6.00000
7. Push SET. This moves the decimal point to the right.	60.0000
8. Push ENTER repeatedly until display shows noStor.	OFFSEt, rAnGE, SLOPE, SP LO, SP HI, GAtE t, CnFG 1, CnFG 2, noStor
9. If you wish to store the updated program into non-volatile memory, push SET to change from noStor to StorE.	StorE
10. Push ENTER one last time. If the previous display was StorE, this will save the selection in nonvolatile memory.	Display shows FrEQ, the current frequency, followed by the first reading.

2.5 SETUP PARAMETERS

Unless programmed for a specific application, your P6000 has been factory-set to operate in the Frequency mode with a Multiplying Scale Factor = 1, Offset = 0 and Auto-ranging. However, you can change the factory setup as required by your application. Table 2-1 shows the Standard Factory Setup and alternate selections.

SETUP PARAMETERS	STANDARD FACTORY SETUP	OTHER POSSIBLE VALUES OR POSITIONS
Function (Func)	Frequency (FrEq)	Period, Frequency Ratio, Time Interval and Totalize
Scale (SCALE)	Multiply by 1. (A .SC , 1.00000)	Multiply or divide by a number between -99999 and 999999 with 6 possible decimal point positions.
Offset (OFFSEt)	Zero (000000.)	Any value between -99999 and 390000* with 6 possible decimal point positions
Range (rAnGE)	Fixed Range D.P. = 1 FFFFFF.	Fixed range with 6 possible positions for the displayed decimal point (F.F.F.F.F.F.) or Auto range (Auto)
Trigger Slope (SLOPE)	A and B Positive slopes (A POS , b POS)	Negative slope (A nEG and/or b nEG)
Setpoint Low (SP LO)	Zero (0.00000)	Any value between -99999 and 999999 with 6 possible decimal point positions
Setpoint High (SP HI)	100000.	Any value between -99999 and 999999 with 6 possible decimal point positions
Nominal Gate Time (GAtE t)	0.3 Second (00.30)	Any value between .01 and 99.99 seconds
Configuration 1 (CnFG 1)	(000000)	Any combination of zeros and ones
Configuration 2 (CnFG 2)	(000001)	Any combination of zeros and ones
Calibration Value (CALIb)	as appropriate	Any value between -99999 and 999999 ppm

Table 2-1 Standard Setup Parameters

* When the scale factor is negative, the offset value can be -99999 to +999999.

SETUP PARAMETERS	STANDARD FACTORY SETUP	OTHER POSSIBLE VALUES OR POSITIONS
PUSH-ON JUMPERS	(See Section 5 for jumper functions)	
SA, Input Filter (on main board)	M Position	S, F or I Position
SB, Input Filter (on main board)	M Position	S, F or I Position
S7, Lock-out jumper (on display board)	'2' Position	'1' or '3' Position
S8, Lock-out jumper (on display board)	Jumper Installed	No Jumper

Table 2-2 Standard Factory-Set Jumper Selection

3.1 INTRODUCTION

This section provides information regarding signal inputs, programming parameters and control inputs. See Section 4.0 for front panel pushbutton programming, 7.0 for remote programming.

3.2 SIGNAL INPUTS

NOTE: If the input signal is disconnected, the last reading remains on the display.

The signal inputs, A and B, are available on pins 1 and 2 (pin 3 is the signal ground return) of the signal screw-terminal connector TB2 (Figure 2-1). The inputs are TTL/CMOS compatible and a 20 k pull-up resistor is provided on each input for contact closure compatibility. If the input signal has a high source impedance (can't sink .25 mA) with a low level less than .8 volts and a high level greater than 2.0 volts, the input can be measured by disconnecting the two pull-up resistors, R3 and R6.

When the operating function is Frequency, Period or Totalize, only the A input signal is measured. When the function is Time Interval or Frequency Ratio, both input signals are active.

Use main board pin groups SA and SB for selecting the frequency response of the A and B inputs. In Position F (Fast), the maximum frequency is 7 MHz; in Position M (Medium), the maximum frequency is about 100 kHz; in position S (Slow), the maximum frequency is about 3 kHz. For maximum noise rejection, select the lowest frequency response position that is compatible with your input frequency.

Also on SA and SB, the I jumper connects the signal conditioner output. (Refer to Figure 1-1.)

P6000 is shipped with jumpers on M in SA and SB (see Figure 3-1).

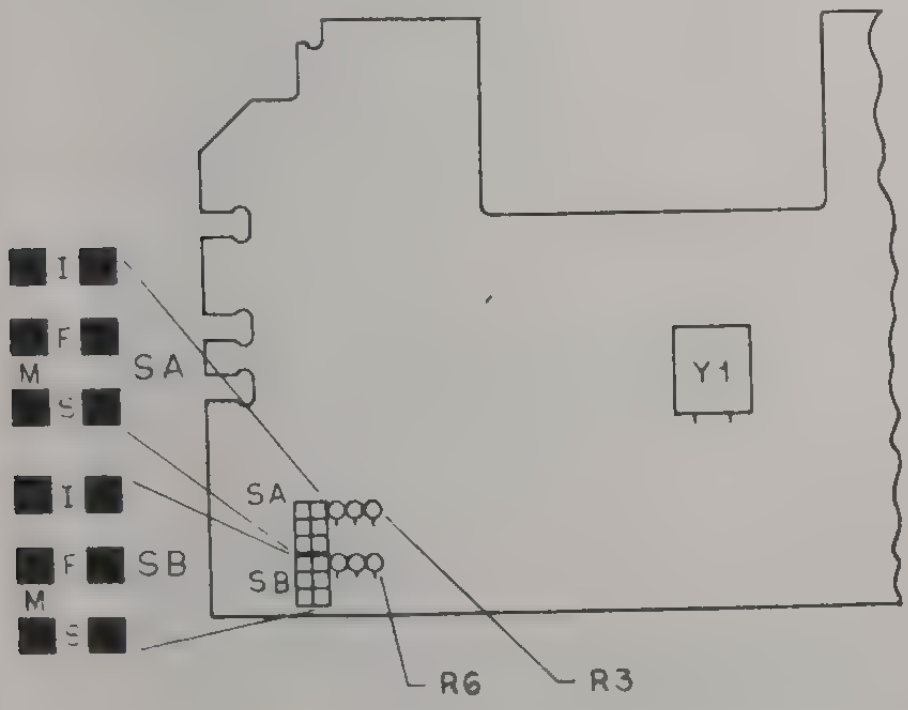


Figure 3-1 Main Board Jumper Selection for Frequency Response

Although the inputs are TTL-compatible when jumpers are in the M or S positions of SA and SB, the inputs are protected against over-voltage up to ±25 volts. This allows measurement of a 24 V logic signal at frequencies up to 100 kHz. In precision time-interval measurements, jumpers must be installed on the F position of SA and SB for minimum trigger error. Table 3-1 shows the maximum trigger error for two square wave inputs when trigger slopes of A and B inputs are the same (e.g., A POS and b POS or A nEG and b nEG).

SA and SB Positions	Time Interval Maximum Trigger Error
F	30 ±70 ns *
M	30 ±250 ns *
S	±10 µs *

* The same trigger slope for A and B inputs are selected.

Table 3-1 SA/SB Positions and Maximum Trigger Error

In the Totalize mode, the A input signal can be gated by the External Gate input. For more information about the External Gate input, refer to Section 3.10 .

3.3 OPERATING FUNCTIONS (Func initially displayed)

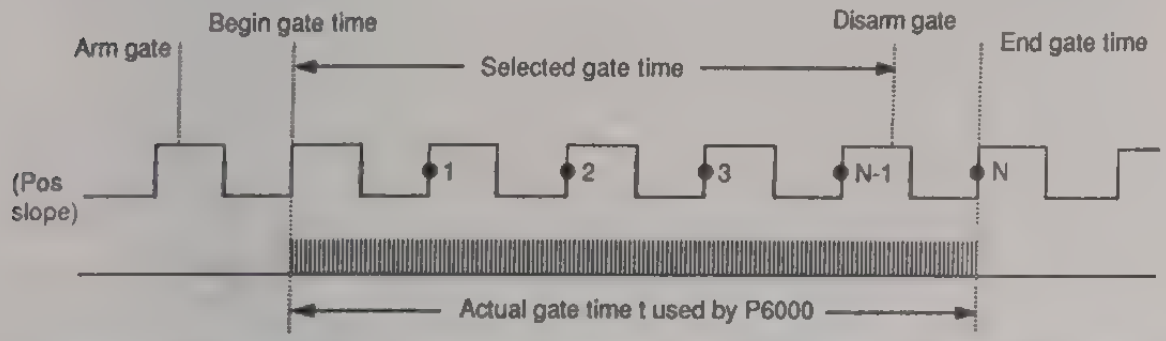
Repeated pushes of SET cycles the display through FrEq , PEriod , Fr b/A , ti Int , and totAL .

Stopwatch capability is also provided in Time Interval and Totalize functions (refer to Section 3.3.6).

3.3.1 Frequency (FrEq displayed)

During a selected gate time, the A counter counts the A input pulses; the B counter counts the oscillator clock pulses. After the Gate Time is over, the arithmetic block reads both counters and calculates the frequency in Hz (Figure 3-2).

$$\text{Frequency (Hz)} = \frac{\text{Number of pulses}}{\text{Gate Time (seconds)}} = \frac{\text{Counter A}}{\text{Counter B / Internal Clock Frequency}}$$



The P6000 measures frequency or period by counting the number of 11.059 MHz clock pulses during the actual gate time t determined by an integral number of input pulses N. This reciprocal counting technique allows high-accuracy low-frequency measurements. Frequency is calculated from N/t, period from t/N.

Figure 3-2 Frequency Timing

* 3.3.2 Period (PEr iod displayed)

This is the same as Frequency except that the arithmetic block calculates the period in milliseconds.

$$\text{Period (ms)} = \frac{\text{Total Time (ms)}}{\text{Number of Periods}} = \frac{\text{Counter B X 1000 / Internal Clock Frequency}}{\text{Counter A}}$$

3.3.3 Time Interval (t i Int displayed)

In this mode, the A-input active edge (selected slope) sets a flip-flop (not shown in the block diagram) and the B input active edge resets this flip-flop. The oscillator clock pulses are counted by the B counter (Figure 1-1) during each interval that the flip-flop is set. The A counter counts the number of intervals during the selected gate time. After the gate time is over, the arithmetic block calculates the time interval in milliseconds.

$$\text{Time Interval (ms)} = \frac{\text{Total Time (ms)}}{\text{Number of Intervals}} = \frac{\text{Counter B X 1000 / Internal Clock Frequency}}{\text{Counter A}}$$

Greater accuracy is achieved by averaging several time intervals. Use a shorter gate time if single time-interval measurement is desired. If zero gate time is selected, the measured interval must not exceed 169 milliseconds. The measurement accuracy is determined by the interval time, gate time, and trigger error (Table 3-1).

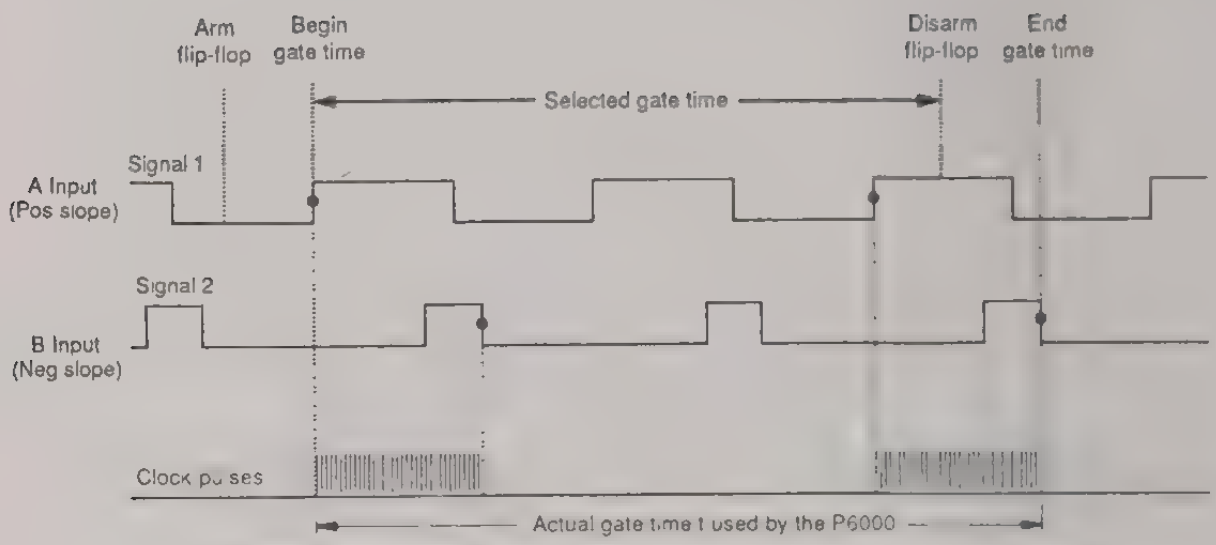

Arm flip-flop
Begin gate time
Disarm flip-flop
End gate time
Selected gate time
Signal 1
A Input (Pos slope)
Signal 2
B Input (Neg slope)
Clock pulses
Actual gate time t used by the P6000
The P6000 averages every other time interval when a gate time other than zero is selected

Figure 3-3 Time-Interval Timing

3.3.4 Frequency Ratio

When the function is set to **Fr bA** (Frequency Ratio), the A counter counts A-input pulses and the B-counter counts B input pulses (Figure 1-1) during the selected gate time. Then, the arithmetic block reads both counters and calculates the frequency ratio.

$$\text{Frequency Ratio} = \frac{\text{B Input Frequency}}{\text{A Input Frequency}} = \frac{\text{Counter B}}{\text{Counter A}}$$

The resolution above 5 kHz is proportional to the B input frequency and the gate time. The A and B frequencies must be more than 0.0125 Hz (80-second period).

$$\text{Accuracy } (F_B > 5 \text{ kHz}) \quad \pm \frac{1}{(F_B) \cdot (\text{Gate Time})}$$

$$\text{Accuracy } (F_B < 5 \text{ kHz}) = \pm \frac{1}{5000\ (\text{Gate Time})}$$

Where: F_B = B input frequency in Hz

For more information on the theory of operation, refer to Appendix A.

3.3.5 Totalize (totAL displayed)

NOTE: A fixed decimal point (Fixed Range) must be selected in the Totalize mode.

In Totalize, only the A counter is active (Figure 1-1) and counts the A-input pulses. The A-input pulses can be repeatedly gated with a signal (with programmable polarity) on the External Gate input without any cumulative error (Figure 3-4). This feature makes the P6000 very useful in the stopwatch applications where cumulative time is desired (also see Example 2).

In case of a power failure, the P6000 blanks the display and stores the latest reading in the nonvolatile memory. At power on, if the setup function is Totalize, this reading will be restored. To disable the above feature, connect pin 16 of the rear connector, P2, to GND, pins 6 and 17 of P2 and pin 3 of TB2 (Figure 2-1). When the P6000 is equipped with one of the DC power options, this input is connected to GND internally. This prevents display blanking on power loss.

In totalizer mode, the P6000 counts positive or negative edges. An external-gate signal will not produce a false count, as in conventional counters

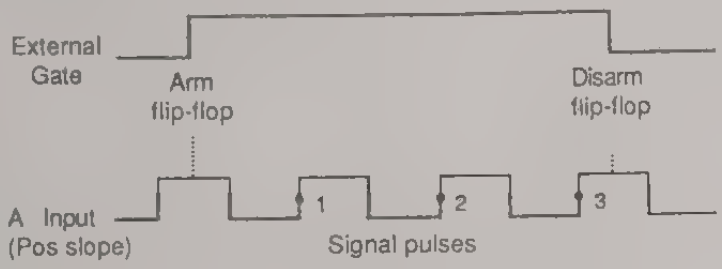


Figure 3-4 A-Input Pulse, Gated With Signal on External Gate Input

3.3.6 Stopwatch Application (No separate display)

Stopwatch is not one of the programmable functions of the P6000. However, stopwatch applications can be implemented using either Time Interval or Totalize functions. If the result should be reset after each measurement, the function is to be set to Time Interval. If cumulative time is desired, the totAl mode should be used.

Example 2:

Using the Time Interval mode in a Stopwatch application, SET the following setup parameters. (Other parameters should be **the same as factory setup. See Table 2-1.**)

Function (Func) = Time Interval (ti Int)
Scale factor operation = Divide (DIVSC)
Scale factor value = 1000.
Range (rAnGE) = fixed, d.p. = 2 (FFFFF.F)
A input = reset and start
B input = stop and display = Display in seconds

NOTE: For display in minutes, set the divide scale factor value equal to 60000.

Example 3:

Using the Totalize mode in a stopwatch application, connect the 400 Hz, Digit 6 output (Pin 20 of P2) to the A input.

Function (Func) = Totalize (totAL)
Scale factor = Divide by 400 (ArSC)
Range (rAnGE) = fixed, d.p. = 2 (FFFFF.F)

Counter starts counting when the External Gate input is high and stops when this input is low. The counter can be reset with a low-level pulse on the $\overline{\text{RESET}}$ input of 2.2 milliseconds or more.

NOTE:	If start and stop with two separate signals is desired, the spare flip-flop can be used (see Figure 3-5).

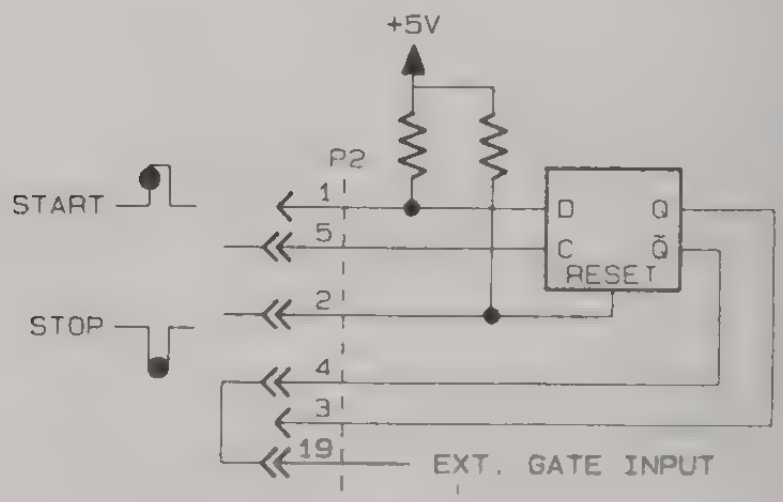


Figure 3-5 Using the Spare Flip-Flop in a Stopwatch Application

3.4 HOW TO USE THE SCALE AND OFFSET

The P6000 provides either a multiplying or a dividing scale factor, ranging from -99999 to 999999 with a choice of any of the six decimal point locations. After measuring the input(s), the P6000 multiplies or divides the result by the scale factor and then adds the offset. The offset value ranges from -99999 to 390000* with any of the six decimal points.

A .5C => Display = (measurement · scale) + offset
A/5C => Display = (measurement / scale) + offset

* When Scale Factor is negative, the offset value can be -99999 to 999999.

Example 4:

Reading in RPM is desired. Function = Frequency (Hz)

Number of pulses per revolution (generated by a transducer)	Scale Factor Operator	Scale Factor Value
1 multiply by 60	A .5C	600000
2 multiply by 30	A .5C	300000
5 multiply by 12	A .5C	120000
7 multiply by 8.57143	A .5C	857143
N multiply by $\frac{60}{N}$ or divide by $\frac{N}{60}$	A .5C A/5C	60/N N/60

Example 5:

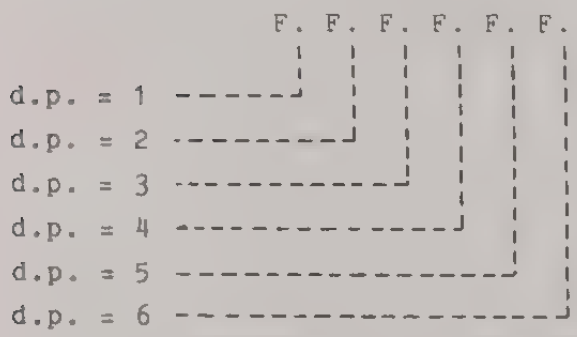
A transducer generates one pulse for every bottle filled on a conveyor line. Each carton has 24 bottles and there are 1,000 cartons to be filled. It is desired to display the number of remaining cartons.

In this case, counter should start from 1,000 and count downward one count for every 24 input pulses.

Function = Totalize
Offset = 001000.
Scale = divide by -24 (A/5C , -00024.)
Range = fixed, d.p. = 1 (FFFFFF.)

3.5 WHAT IS THE RANGE? (rAnGE is displayed)

Your P6000 offers a choice of auto-ranging (floating decimal point), or fixed range with a fixed decimal point in one of six possible locations:



NOTE: Auto-range is not available in Totalize mode.

In auto-range, the display resolution is automatically determined by the measurement accuracy and maximum display capacity (6 digits). For example, if the input frequency is 400.049 Hz but the measurement accuracy is limited to .01 Hz because of a short gate time, the P6000 displays only 5 digits 400.05. Using a fixed range, the display resolution is dictated by the selected decimal point. It should be noted that the unit of measurement remains unchanged (Example 6).

Example 6:

For an input frequency of 400.049 Hz (D6 output), with .3 sec gate time, different ranges will display the following:

Range	Display
Auto-range (Auto)	400049
Fixed range, d.p.=1 (FFFFFF.)	400
Fixed range, d.p.=2 (FFFFF.F)	400.0
Fixed range, d.p.=3 (FFFF.FF)	400.05
Fixed range, d.p.=4 (FFF.FFF)	400.049
Fixed range, d.p.=5 (FF.FFFF)	400 E2
Fixed range, d.p.=6 (F.FFFFF)	400 E2

In the last two ranges, the reading exceeds the full scale (99.9999 and 9.99999). Thus, the P6000 displays in exponential format.

This example shows that you cannot use a fixed decimal point to make the display 10 times greater or smaller. For this purpose, **the scale factor should be used.**

Using a fixed range, the decimal point may be selected to display a resolution greater than the measurement accuracy. In this case, if Digit 4 of Configuration 1 is set =1, the P6000 will flash the **inaccurate digit(s).**

Example 7:

A input frequency = 400 Hz (or the D6 output, Pin 20 of connector P2)
B input frequency = 400 Hz
Function (FUNC) = frequency ratio (FR bA)
Range (rANGE) = fixed, decimal point = 6 (F.FFFFF)
Gate Time = .3 second
Configuration 1(CnFG 1)= 001000 =>Flash inaccurate digit(s)
Display reads: 1.00000

The two least-significant-digits flash to show they are not accurate.

3.6 TRIGGER SLOPE (SLOPE is displayed)

The trigger slope (active edge) of the A and B inputs are programmable. This feature is very useful in Time Interval measurements. When the function is Frequency, Period or Totalize, only the A input is active and only trigger slope A can be set.

Example 8:

Pulse width measurement
Connect the signal (or the D6 output) to A and B inputs
Function = Time Interval (t, Int)
Range = Fixed, d.p. = 4 (FFF.FFF)
Trigger slope = A positive and B negative (A POS and b nEG)

Display reads the t_H value in milliseconds (.417 ms)

Now change the slopes to A negative and B positive. Display will read the t_L value (2.084 ms). If you change the slopes to A positive and B positive, the display will read the period of input signal (2.500 ± .001 ms). This is the same as a period measurement but with less accuracy, since averaging is less extensive.

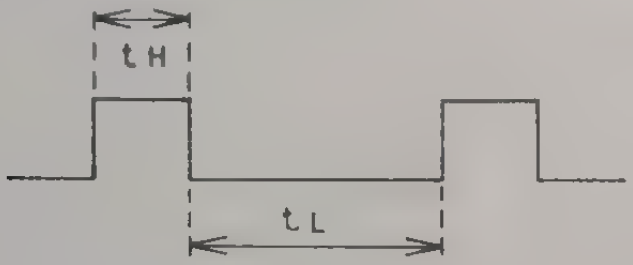


Figure 3-6 Pulse-Width Measurement

3.7 HOW TO USE THE SETPOINTS AND ALARM OUTPUTS

The P6000 provides two setpoints (SP LO and SP HI) and three corresponding open-collector active-low alarm outputs: LO, GO and HI (pins 9, 12 and 10, respectively). The LO or HI LED on the display will light up and the associated output is active low when the corresponding alarm condition is met. When the reading is between the two setpoints, the GO output is active low. When active, each output can sink 150 mA at 1 volt.

An alarm state will be latched when you set Digit 4 of Configuration 2 to '1' (refer to Section 3.9), e.g., CnFG 2 = XX1XXX, where the X's mean don't care (set to obtain other options).

When an alarm occurs, the alarm will stay on until either manually reset (pushing the three, center front-panel pushbuttons together) or electrically reset by a low-true signal applied to the reset terminal for at least 2.2 milliseconds.

If both setpoints are positive (1), the LO setpoint can be converted to a second HI setpoint by making Digit 5 of Configuration 2 a '1', e.g., CnFG 2 = XXXX1X; that alarm then becomes an active low output when the reading is greater than that setpoint.

Example 9: If Setpoint HI is 500.0 and Setpoint LO is 100.0, then the alarm outputs for different readings are:

Reading	Alarm Outputs		
	LO		HI
501.0	High	High	
500.	High	High	Low
10.5	High	Low	High
- 99.3	High	Low	High
-100.2	Low	High	High

For precise alarm setting, use the fine Pos. resolution, i.e., display 399.000 rather than 00039, since the alarm comparison is made using the setpoint resolution.

Example 1: If the A input frequency is 399.993 Hz and the function is frequency, you have:

Setpoint High	Range	Display	Alarm Activation	Alarm Deactivation
000399.	Auto-range	399.993	399. = 399.	
00399.0	Auto-range	399.993	399.9 > 399.0	
00399.9	Auto-range	399.993	399.9 = 399.9	
000399.	Fixed, d.p.=2 (XXXXX.X)	400.0 (rounded)	399. = 399.	

1 [illegible]

3.8 GATE TIME (GATE t is displayed)

The reading rate of the P6000 can be partially controlled by changing the value of Gate Time, which is a nominal value slightly shorter than the actual gate time. If the input frequency is high enough, the total reading time is the sum of Gate, Calculation and Communication times (Figure 3-7).

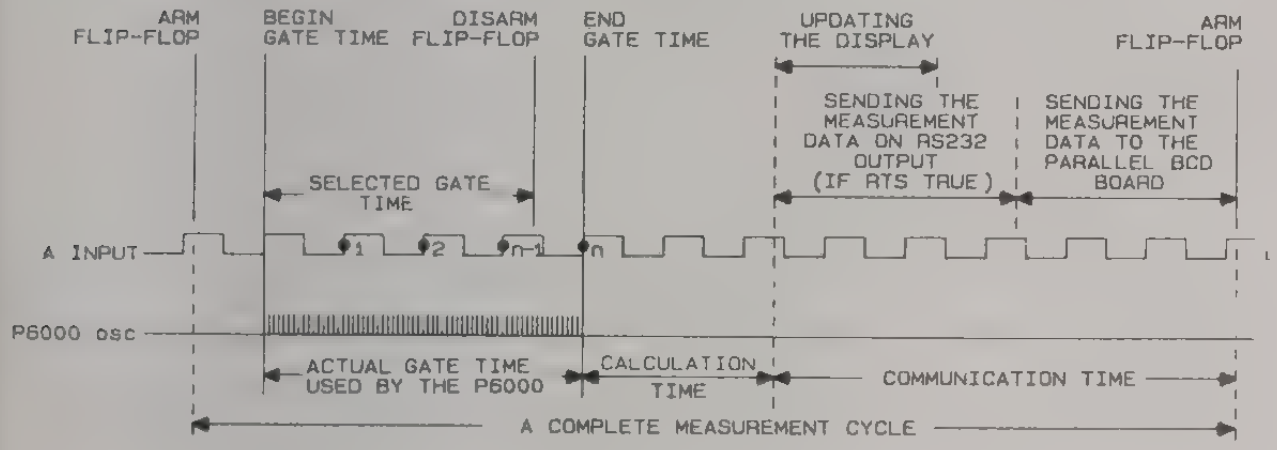


Figure 3-7 Measurement Cycle

For the P6000, unlike other counters, changing the gate time does not change the reading: it only changes the averaging time and corresponding accuracy, because the reading is calculated from the integral numbers of input cycles and internal oscillator pulses received during the actual gate time. The P6000 gate time can be selected as any value from 00.01 to 99.99 sec. If 00.00 gate time is selected, the P6000 uses 2.7 milliseconds except in the time interval mode, which uses .1 millisecond. An LED is provided on the left of the display to indicate the gate-open status. When measuring lower frequencies, this LED indicates the status of the measurement cycle.

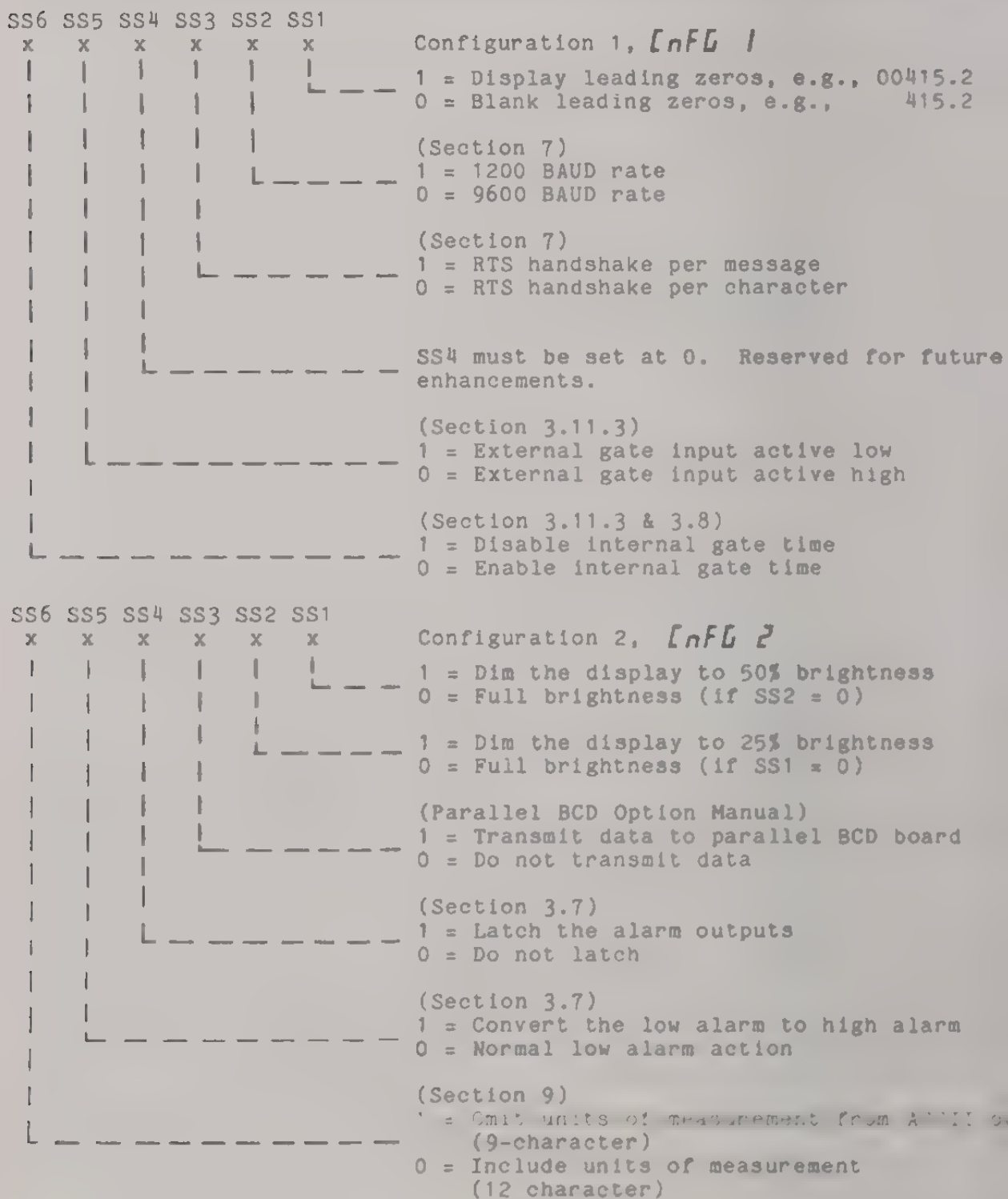
Gate Time has no significance when the function is Totalize; the P6000 updates the display as quickly as possible.

An external gate signal can be used instead of the internal gate time in frequency, period or frequency-ratio modes. This signal should be connected to the External Gate input (pin 19 of the connector, P2). When using an external gate signal, the internal gate time should be disabled by setting Digit 6 of Configuration 1 (CnFG 1 = 1XXXXX). The gated period is normally that when the gate signal is positive, but negative polarity can be selected by setting Digit 5 of Configuration 1 (CnFG 1 = 11XXXX).

For more information about the external gate, refer to section 3.11 .

3.9 CONFIGURATION 1 AND 2 (CnFG 1 or CnFG 2 displayed)

Each configuration word consists of six Software Switches (SS6-SS1 that can be set to 1 (on) or Ø (off). Each switch controls one digi (characteristic) of the P6000; e.g., SS6 of Configuration 1 disable the internal gate time, SS4 of Configuration 2 enables latched alarms etc. Following are the functions of the configuration switches. Fo more information about each switch, refer to the corresponding section


SS6 SS5 SS4 SS3 SS2 SS1
x x x x x x
Configuration 1, CnFG 1
1 = Display leading zeros, e.g., 00415.2
0 = Blank leading zeros, e.g., 415.2
(Section 7)
1 = 1200 BAUD rate
0 = 9600 BAUD rate
(Section 7)
1 = RTS handshake per message
0 = RTS handshake per character
SS4 must be set at 0. Reserved for future enhancements.
(Section 3.11.3)
1 = External gate input active low
0 = External gate input active high
(Section 3.11.3 & 3.8)
1 = Disable internal gate time
0 = Enable internal gate time
SS6 SS5 SS4 SS3 SS2 SS1
x x x x x x
Configuration 2, CnFG 2
1 = Dim the display to 50% brightness
0 = Full brightness (if SS2 = 0)
1 = Dim the display to 25% brightness
0 = Full brightness (if SS1 = 0)
(Parallel BCD Option Manual)
1 = Transmit data to parallel BCD board
0 = Do not transmit data
(Section 3.7)
1 = Latch the alarm outputs
0 = Do not latch
(Section 3.7)
1 = Convert the low alarm to high alarm
0 = Normal low alarm action
(Section 9)
1 = Omit units of measurement from A
(9-character)
0 = Include units of measurement
(12 character)

3.10 STORING THE SETUP PARAMETER IN NONVOLATILE MEMORY

At power-on or after pushing the two 'RECALL' buttons simultaneously, the P6000 reads the setup parameters stored in nonvolatile memory and starts a measurement. If you push the 'ENTER' command repeatedly (11 times starting from a measurement for the default setup of S7 and S8), the 'noStor' is displayed. You now have a choice of storing the setup parameters in nonvolatile memory (push the ' ENTER ' button when 'StorE' is displayed) or not storing in nonvolatile memory (push the ' ENTER ' button when 'noStor' is displayed). In either case, the latest setup parameters in active memory are used for current measurements.

The nonvolatile memory can store the setup parameters for ten years and can be rewritten more than 10,000 times. In case of a power failure (loss of AC power), when the P6000 function is Totalize, the display value is stored in nonvolatile memory and restored when power resumes.

3.11 CONTROL INPUTS/OUTPUTS

All of the control I/O lines are located on P2, a 20-pin dual row header at the back of the counter. A 20-position mating mass-termination connector is an option. Alternatively, a 34-pin mass-termination connector option can be used to access both the I/O and RS-232 lines.

3.11.1 $\overline{\text{RESET}}$

This is a TTL/CMOS-compatible, low-true input (pin 18 of the connector, P2) with a 10 kOhm pull-up resistor. A low level of 2.2 milliseconds or more on this input resets the counter. If the P6000 function is Totalize, the offset is displayed and the alarm outputs are updated according to the offset value. In other functions, zero is displayed and the alarm outputs are reset regardless of the setpoint values. The alarm outputs, including the GO alarm, remain in the reset condition until the first measurement is completed. Table 3-2 shows the effect of a reset pulse on the P6000 outputs. The P6000 can also be reset by pushing the three center front panel buttons ('ENTER', 'ADVANCE', 'SET') simultaneously.

OUTPUT	Condition Immediately After Reset	
	Function is Totalize	Function is not Totalize
Display	Offset	Zero
HI, LO and GO alarms	Updated according to the offset value	Reset (to high level)
RS-232 Output	Offset is transmitted	No data is transmitted
Parallel BCD (Option)	Updated according to the display and alarm outputs	

Table 3-2 Effect of a Reset Pulse on the P6000 Outputs

3.11.2 $\overline{\text{HOLD}}$

Except in the Totalize function, the P6000 does not start a measurement when the $\overline{\text{HOLD}}$ input is low ($\overline{\text{HOLD}}$ is true). A high level ($\overline{\text{HOLD}}$ false) of 0.1 millisecond minimum at this time allows the P6000 to start and complete a measurement.

In the totalize function, the display is frozen and no ASCII data is transmitted via the RS-232 port when the $\overline{\text{HOLD}}$ input remains low for a full reading cycle (see Figure 3-8). If the $\overline{\text{HOLD}}$ input goes high for 0.5 millisecond minimum during a reading cycle, the display is updated and ASCII data is transmitted. The parallel BCD data is updated regardless of the $\overline{\text{HOLD}}$ input.

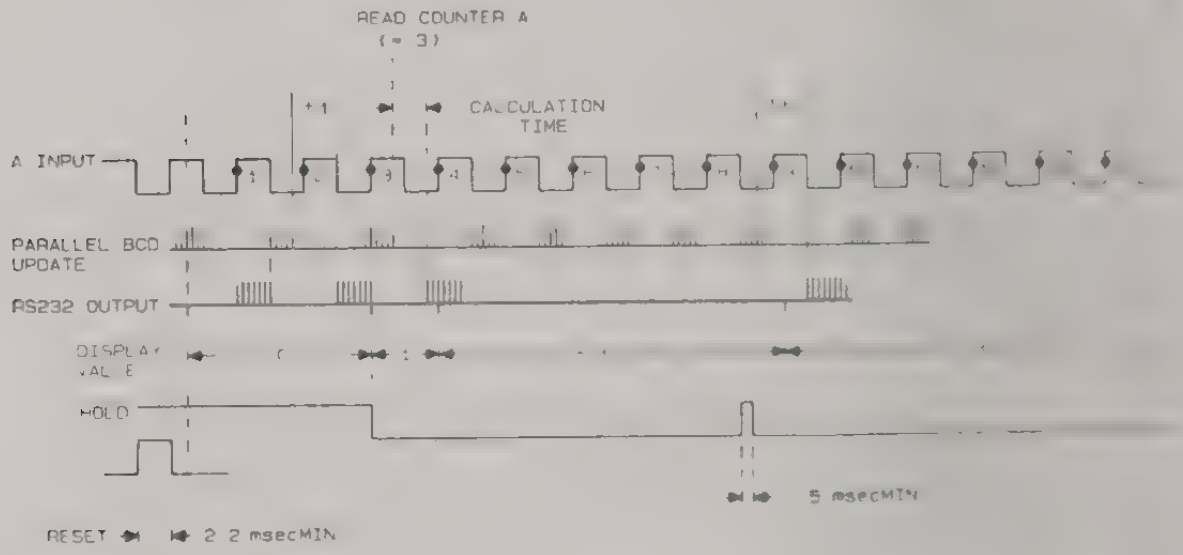


Figure 3-8 Effect of $\overline{\text{HOLD}}$ Signal in Totalize Function

3.11.3 External Gate Input

This is a TTL/CMOS-compatible input with a [illegible] resistor. The polarity used is normally [illegible], but negative polarity can be selected by [illegible] Configuration 1 (CnFG 1 = X1XXXX). With the [illegible] Totalize, the A input pulses are gated with a [illegible] External Gate input. Unlike conventional [illegible], this does not introduce any error.

When the P6000 function is Frequency, Period, or Frequency Ratio, an external gate time signal can be connected to this input instead of using the internal gate time. In these cases, bit 5 of Configuration 1 should be set to allow the external gate time (CnFG 1 = 'XXXXX). The maximum gate time for Frequency Ratio is 40 seconds. There is no maximum gate time in Frequency or Period. Burst frequency measurement is possible, using an external gate signal without the internal gate time. See Theory of Operation for more information.

3.11.4 Blank Enable Input/Line Frequency Output

This signal is available on pin 16 of the P2 connector. The output is normally at high level with a 7.5 kOhm pull-up resistor. When the 50/60 Hz AC power is present, two low-level pulses (about 3 milliseconds) appear on this output for each AC power cycle. The signal can be tied to the A input for low frequency measurement (scale factor = 0.5, multiplier).

This pin can also be used as an input. When tied to ground, it prevents display blanking in case of an interruption in AC power. Connection of this input to a TTL or high speed CMOS (HC Series) is not recommended since, in the presence of the AC power, it is pulled down with a 301 ohm resistor twice per cycle.

3.11.5 Digit 6 Output

This is a TTL/CMOS compatible signal available on pin 20 of P2. The frequency of this signal is 400.0 Hz ±.1% with 1/6 duty cycle. This output can drive 5 LSTTL loads.

> NOTE: This is a display multiplex signal and must not be pulled down with a load more than .2 mA.

3.11.6 Spare Inverter and Flip-Flop

A TTL/CMOS compatible Schmitt trigger inverter is provided for user's applications. The input and output of this inverter are available on pins 14 and 15 of P2, respectively. A spare 'D' type flip-flop is also provided.

The inputs (clock, clear, and D) are CMOS compatible (HI level > 3.5 V, LO level < .9 V). However, a 20 k pull-up resistor is provided on clear and D inputs to make them TTL at low frequencies (Figure 3-5). This flip-flop can be configured to divide the clock frequency by two (connect Q output to the D input), thus increasing the maximum operating frequency of the P6000 to 14 MHz.

4.1 GENERAL

The P6000 may be programmed using the three center pushbuttons (SET, ADVANCE and ENTER) or by the equivalent electrical communication to the rear connector (e.g., RS-232).

This instrument is designed to present a "serial menu" similar to that used for digital clocks and watches. Pushing the appropriate button rolls the display through the P6000 functions, parameter names and digits, repeating (for corrections) as often as desired.

This programming results in the active program by which the P6000 makes its measurements. At the end of the programming sequence, the choice of 'StorE/noStor' is provided to allow this active program to be preserved in the nonvolatile memory or to be used temporarily, keeping a different program for later use in the nonvolatile memory. The stored program can become the active program (discarding the one currently in operation) by simultaneously pushing both RECALL buttons.

For security purposes, programming with front panel pushbuttons can be partially or completely disabled by S7 and S8, the two lock-out jumpers on the display board, as described in Table 4-1 below. (Refer to Section 5 for illustration of jumper locations.)

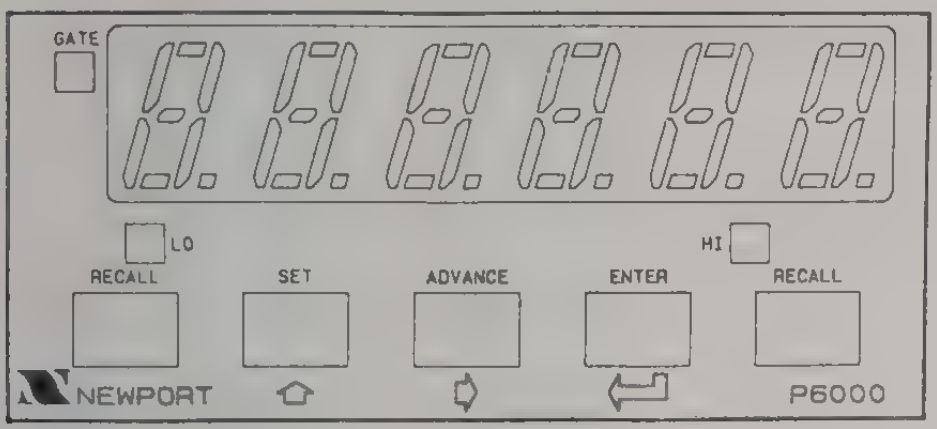
S7	S8	MENU ITEMS LOCKED-OUT
3	IN	All menu items available, no lock-out.
2	IN	CALIB (Calibration Value) locked-out.
1	IN	CALIB and STORE (Storing the program in the nonvolatile memory) locked-out.
OUT	IN	All menu items locked out except SP HI (Setpoint High) and SP LO (Setpoint Low). In these positions, an ENTER stores any new value in both active and nonvolatile memory.
Don't Care	OUT	The programming pushbuttons are completely disabled.

Table 4-1 Lock-Out Jumpers

4.2 SELECTING THE FUNCTION TO BE PERFORMED

Apply power to the P6000 and the meter will briefly display the chosen function stored in the nonvolatile memory, which becomes the active program upon power-up.

The counter now switches to Measurement mode (in about one second) if there are signal pulses. If the programming was correct, there is nothing further to do but utilize the P6000 output data. To review or alter the programming, push ENTER. This will now display 'Func' instead of measurements. Repeated SET commands now roll the display through 'FrEq', 'PEriod', 'ti Int' (for time interval), 'Fr b/A' (Frequency ratio B input divided by A input), and 'totAL' (for totalizing, e.g., counting). The desired one of these is selected by pushing ENTER when it is displayed, moving you to scale factor selection.

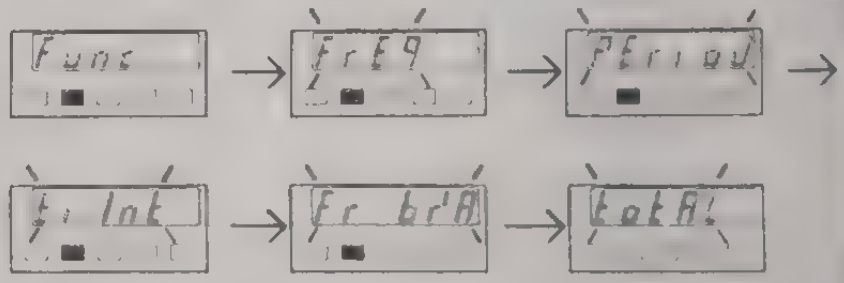
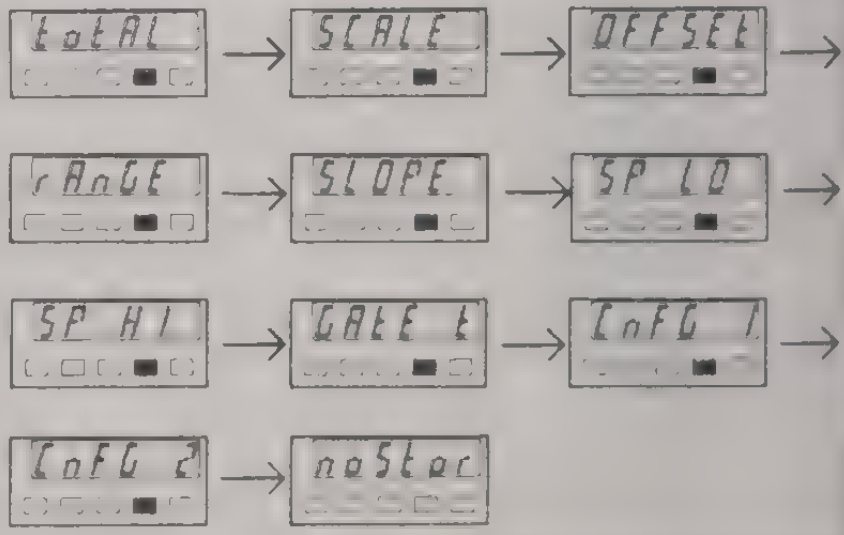


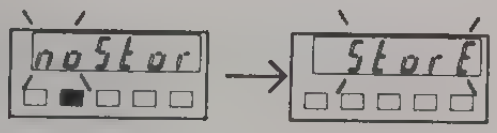
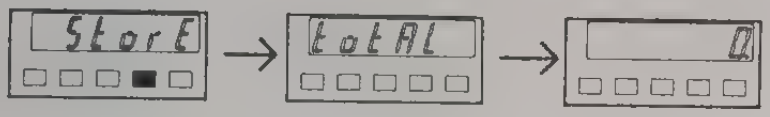
If the function was already correct, you can move directly to scale factor with an ENTER when 'Func' is displayed.

Example 11:

To use the P6000 as a totalizer all the time, the function should be set to totAl and this change should be stored into the non-volatile memory. It restores at power-on.

NOTE: All examples provided in the section assume the default setup parameters are used to start.

DO THIS	DISPLAY SHOWS
Turn on the power.	If a signal is connected to the A input, a frequency reading replaces this display in about one second.
Push the ENTER button once.	
Push SET five times. "totAL" will be displayed.	
Push ENTER ten times. "StorE" will be displayed.	

Push SET once.	
Push ENTER once.	 If the signal is connected, display starts counting up.

4.3 MULTIPLY OR DIVIDE BY A SCALE FACTOR

The input rate may be multiplied or divided by any desired scale factor from -.9.9.9.9.9. to +9.9.9.9.9.9. with a decimal point selected in any position shown.

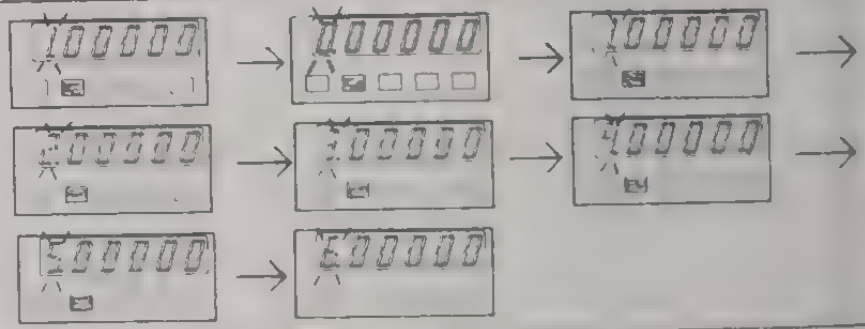
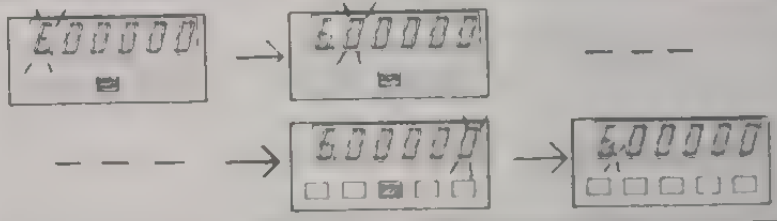
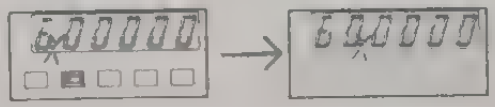
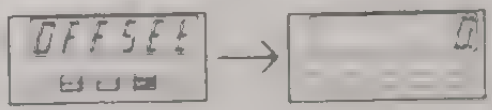
When 'SCALE' is displayed, pushing ADVANCE moves the display to either 'A.SC' or 'A/SC', depending on which was in the program. To switch to the opposite, use SET, but do not yet push ENTER if you also wish to change the scale-factor numerical value or decimal location. (If pushed in error, the menu can be rolled around to SCALE again by 11 ENTERs).

Another ADVANCE moves the active value of the scale factor onto the display, with the Most-Significant-Digit flashing (#6, on the left). If you wish to keep the scale factor as is, push ENTER, and go to 'OFFSET'. To change the MSD, push SET repeatedly until the desired numeral is displayed. Push ADVANCE to move to the next-most-significant digit.

Having altered or accepted all six digits of the scale factor, one more ADVANCE allows you to reposition the decimal point, rolling it around with repeated SETs. When the decimal is correct, ENTER keeps the value and the multiply or divide operator.

Example 12:

It is desired to measure the input frequency in RPM . The input frequency is normally displayed in Hz. To change the unit of measurement to RPM, the value in the display should be multiplied by 60. Therefore, a multiplier (scale factor) of 60 is required.

DO THIS	DISPLAY SHOWS
Push ENTER twice.	
Push ADVANCE twice. The current scale factor value will be displayed.	
Push SET seven times to set Digit #6 (left-most) to 6.	
Push ADVANCE six times to select the decimal point.	
Push SET once to set the decimal point.	
Push ENTER once.	
Push the three center pushbuttons simultaneously to reset the counter and start a measurement.	

If a signal is connected to the A input, a frequency reading in RPM replaces this display.

4.4 SELECTING AN OFFSET

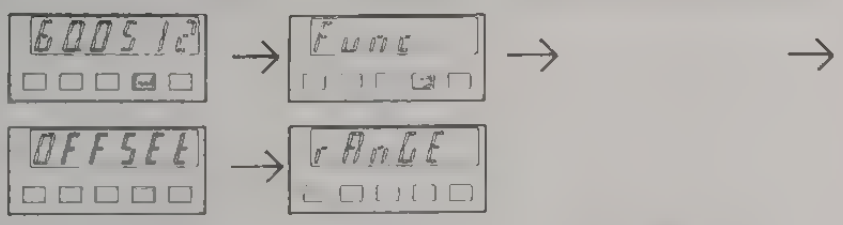
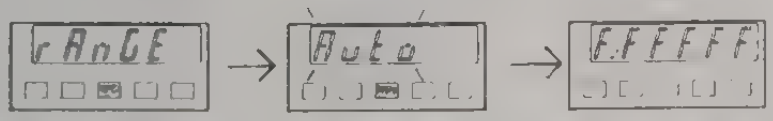
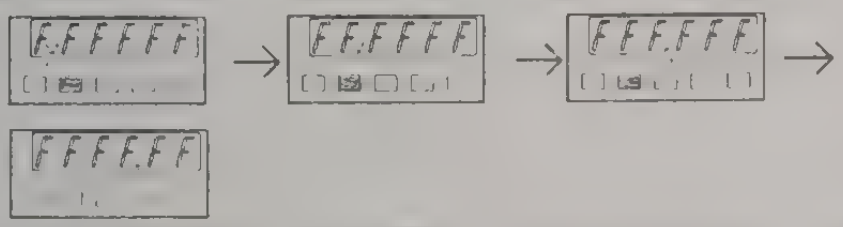
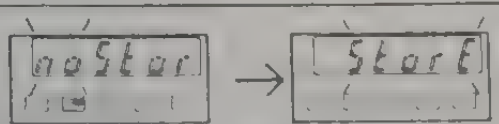
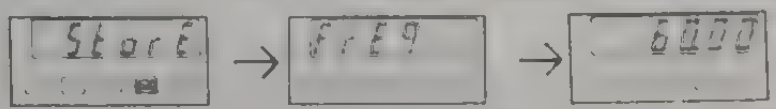
The P6000 allows the scaled measurement value to be offset by any number from -99999 to +999999 with the decimal in any position. However, if the Scale Factor is positive, the offset must not exceed 390,000 with any decimal point. Pushing ADVANCE when OFFSET is displayed moves the display on to the offset value, which can be altered with the SET and ADVANCE pushbuttons just like the scale factor discussed above. When the offset value is correct, or to accept the value shown, push ENTER; this moves the display to rAnGE.

4.5 CHOOSING AUTO-RANGING OR FIXED DISPLAY DECIMAL-POINT LOCATION

When rAnGE is shown, ADVANCE displays the active-program choice, which will be either Auto or six F's with a flashing decimal point. The flashing denotes the location of the fixed decimal point.

Example 13:

To monitor line frequency with 4-digit resolution, such as 60.00, connect the line frequency output, pin 16 of P2 to the A input.

DO THIS	DISPLAY SHOWS
Push ENTER four times. "rAnGE" will be displayed.	
Push ADVANCE twice. Display will show "FFFFFF" .	
Push SET three times to set the decimal point.	
Push ENTER until "noStor" is displayed.	
Push SET once.	
Push ENTER once more.	

4.6 SELECTING RISING OR FALLING EDGE TRIGGERS FOR A AND B INPUTS

When SLOPE is displayed:

Push ADVANCE to display the current active program, which is A POS or A nEG. Another ADVANCE will display the B input, B POS or B nEG. Push SET to change from positive to negative or vice versa.

ADVANCE

A POS ⟷ b POS

SET

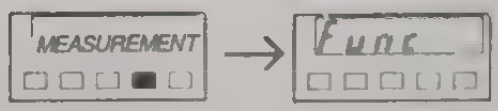
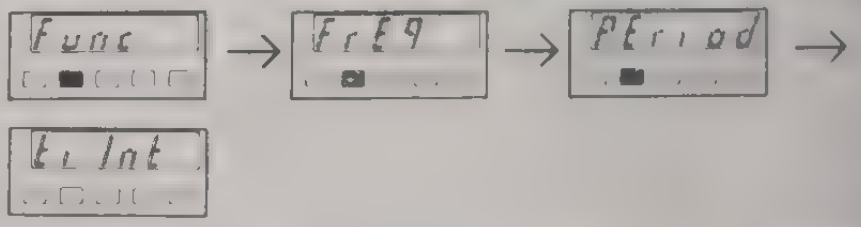
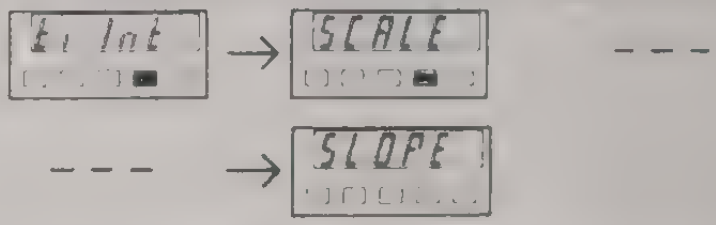
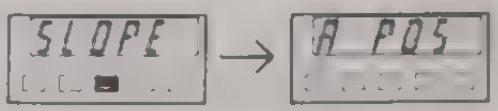
A POS ⟷ A nEG

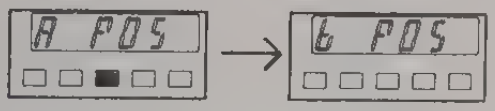
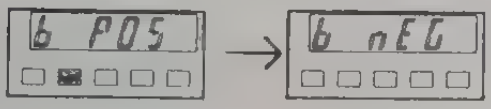
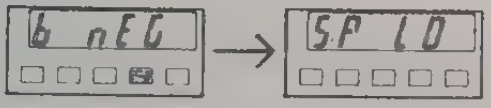
NOTE: B input is not used with Frequency, Period or Totalize functions; therefore, ADVANCE has no effect.

ENTER now displays setpoint selection.

Example 14:

For a pulse width measurement, the time interval function (ti Int) should be chosen. The positive and negative trigger slopes should be set for the A and B inputs (see also example 7, Section 3.0).

DO THIS	DISPLAY SHOWS
Push ENTER once.	
Push SET three times to set the function to Time Interval.	
Push ENTER four times to select the trigger slope.	
Push ADVANCE once to display the current trigger slope.	

Push ADVANCE again.	
Push SET once to change the trigger slope.	
Push ENTER once.	
Push the three center pushbuttons simultaneously.	

3.7 SETTING LOWER AND UPPER ALARM (or CONTROL) VALUES

SP LO is first displayed, and an ADVANCE will show its current value; this can be altered like the scale factor (or offset) by use of ADVANCE and SET.

When correct, ENTER displays SP HI, and the value-changing routine is repeated. Another ENTER moves you to gate-time selection.

3.8 SELECTING A GATE TIME

The measurement gate time is equal to this selection, from 00.00 to 99.99 seconds, plus a small time allowance for computation/communication. (There is no gate time for totalizing, so this choice is not displayed.)

When 'GATE t' is displayed, ADVANCE shows the current value; it may be altered with ADVANCE and SET (in 0.01 second increments). ENTER places that chosen value in the active program.

4.9 CONFIGURATION #1 AND #2

The last ENTER moves 'CnFG 1' onto the display. Here, each digit represents a software switch and any or all of them may be reset. They are binary; alternate '1' and '0' are displayed with SET, and ADVANCE selects the next right-hand digit, rolling around to the MSD after the LSD (right-most digit).

After setting the six software switches of the CnFG 1, an ENTER command moves the display onto CnFG 2. Again, any or all of the software switches of CnFG 2 may be set to '1' or '0' to enable or disable a feature.

The functions of these six software switches are described in Section 3.9 .

4.10 CALIBRATION OF THE CRYSTAL FREQUENCY (CAL16 displayed)

This six-digit value is the ppm (parts-per-million) fine tuning of the crystal, and it is examined/altered by ADVANCE/SET just as the other values discussed above. The default setup locks out this item from the main menu (not displayed). To view or change the calibration value, install jumpers on S7-position 3 and S8 of the display board. For more information about calibration, refer to Section 5.7 .

Another ENTER command moves the display to the last step, noStor.

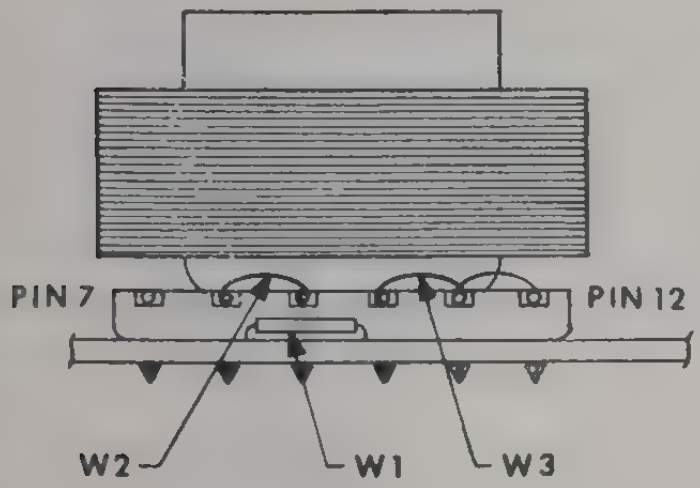
4.11 REPLACING THE STORED PROGRAM WITH THE ACTIVE PROGRAM

At this point, a complete active program has been defined. To use it and begin measurements, push ENTER in response to noStor. This active program may be quite different from that stored in the non-volatile memory. It will be discarded if power is interrupted or if RECALL is used.

This active program may also replace the stored program so that it is automatically restored upon power interruption. Push SET and 'StorE' will be displayed. Now an ENTER writes the active program into the storage and starts measurements. The previously stored program is discarded.

Lock-out pin groups S7 and S8 may be used to prevent discarding of the stored program.

5.1 POWER SELECTION JUMPERS



For 115 V ac power operation, pins 8 and 10 of the power transformer (T1) are connected to pins 9 and 11, respectively. For 230 V ac operation, disconnect the two jumpers and install the W1 jumper on the power supply board (Figure 5-1).

Figure 5-1 Jumper Locations on Power Transformer

5.2 LOCK-OUT JUMPERS

S7 and S8 are two pin groups on the display board for disabling the programming pushbuttons. Table 4-1 lists the lock-out condition for various positions of these jumpers.

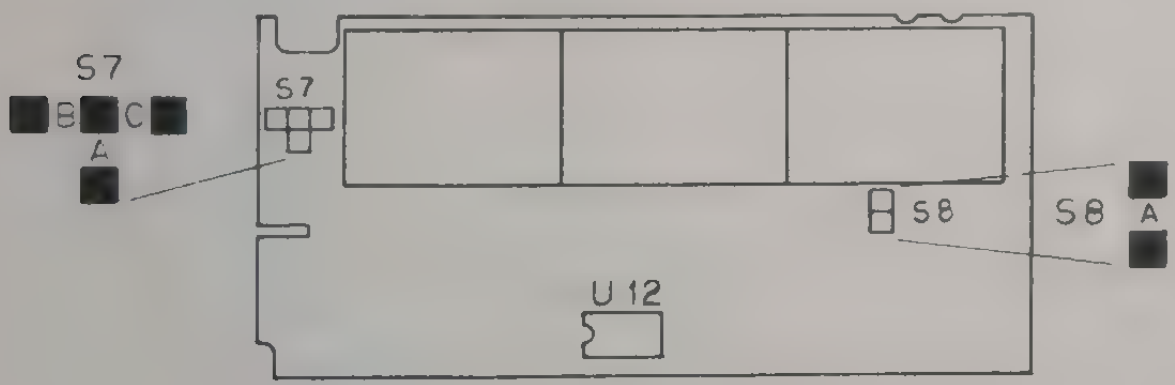


Figure 5-2 Jumper Locations on Display Board

5.3 INPUT JUMPERS

SA and SB are two pin groups used for selecting the frequency response/protection level of the A and B inputs. Listed below are the frequency response and protection level of the A and B inputs for different positions of these jumpers.

SA/SB Position	Frequency Response	Max Input Voltage (Non-Destructive)
F	DC-7 MH (Min)	-.5 to +5.5 V
M (or No Jumper)	DC-100 kHz (typ)	-20 to +25 V
S	DC-3 kHz (typ)	-20 to +25 V
I	Limited by the isolated	signal conditioner

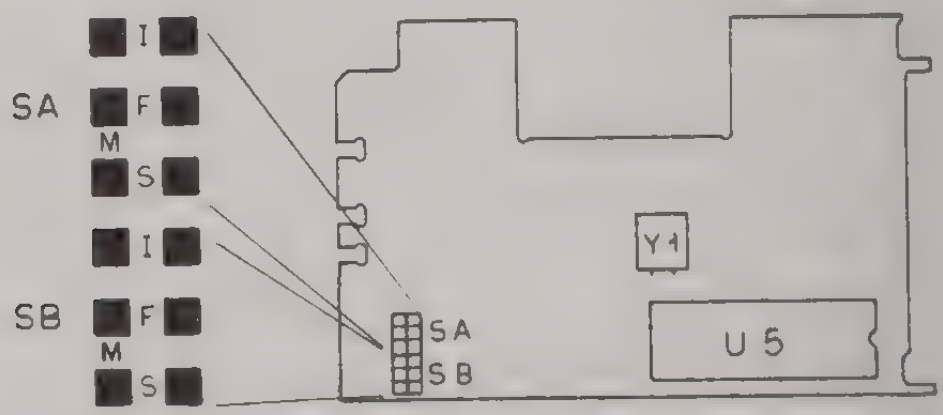


Figure 5-3 Jumper Locations on Main Board

5.4 0 - 20 mA, ASCII OUTPUT

When closed, solder switch J connects a 249 ohm pull-up resistor to this open collector output, providing a 20 mA current source for the 0-20 mA, ASCII output. This output can be used over longer distances than the RS-232 output.

5.5 POWER OUTPUT/INPUT

The P6000 comes with AC power as standard. A DC power supply board is available as an option. Refer to Figure 2-1 for location of rear pins.

5.5.1 AC Power Supply

In the AC powered units, pin 11 of P2 is an unregulated voltage, 5.5 to 9 V and pin 8 of P2 is a +5V regulated voltage. In nontotalize functions, a total of 50 mA can be drawn from these outputs to drive external circuitry. In totalize

function, 20 mA can be drawn if normal or dim display brightness has been selected.

Alternatively, pin 11 can be used as a power input for backup battery connection. Connect the backup battery to this pin with a diode as shown in Figure 5-4. The backup battery should be capable of supplying 60 mA at 6 to 12 V. When the AC power is disconnected, the display turns off. If the external battery can supply 400 mA, display blanking may be prevented by connecting the BLANK ENABLE, pin 16 of P2, to ground. In this case, if the battery voltage is higher than 9 V, the maximum display brightness must not be used.

The backup battery does not drive the isolated signal conditioner circuitry.

In absence of the AC power, the P6000 can be powered with a 5 V ±5% regulated voltage. Connect the external +5 V to pins 8 and 12 (+5 V and V+) of the P2 connector.

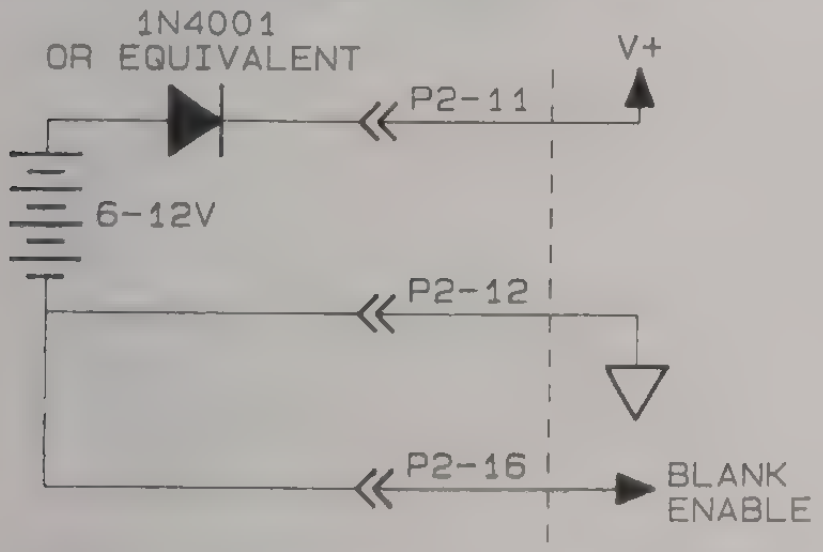


Figure 5-4 Connection of an External Battery

5.5.2 DC Power Supply Option (P64XX)

The power transformer is replaced with a DC to DC converter, which allows operation with a single DC power source.

Refer to Figure 2-1 for rear pin assignments. Connect a 9.5 to 32 V dc power source capable of supplying 1 A current to TB1-pins 2 (positive) and 3 (negative). The outputs of the DC power supply board power the entire P6000 unit.

> **The maximum display brightness (Configuration 2 = XXXXX1) must not be used with a signal conditioner or an upper board option.**

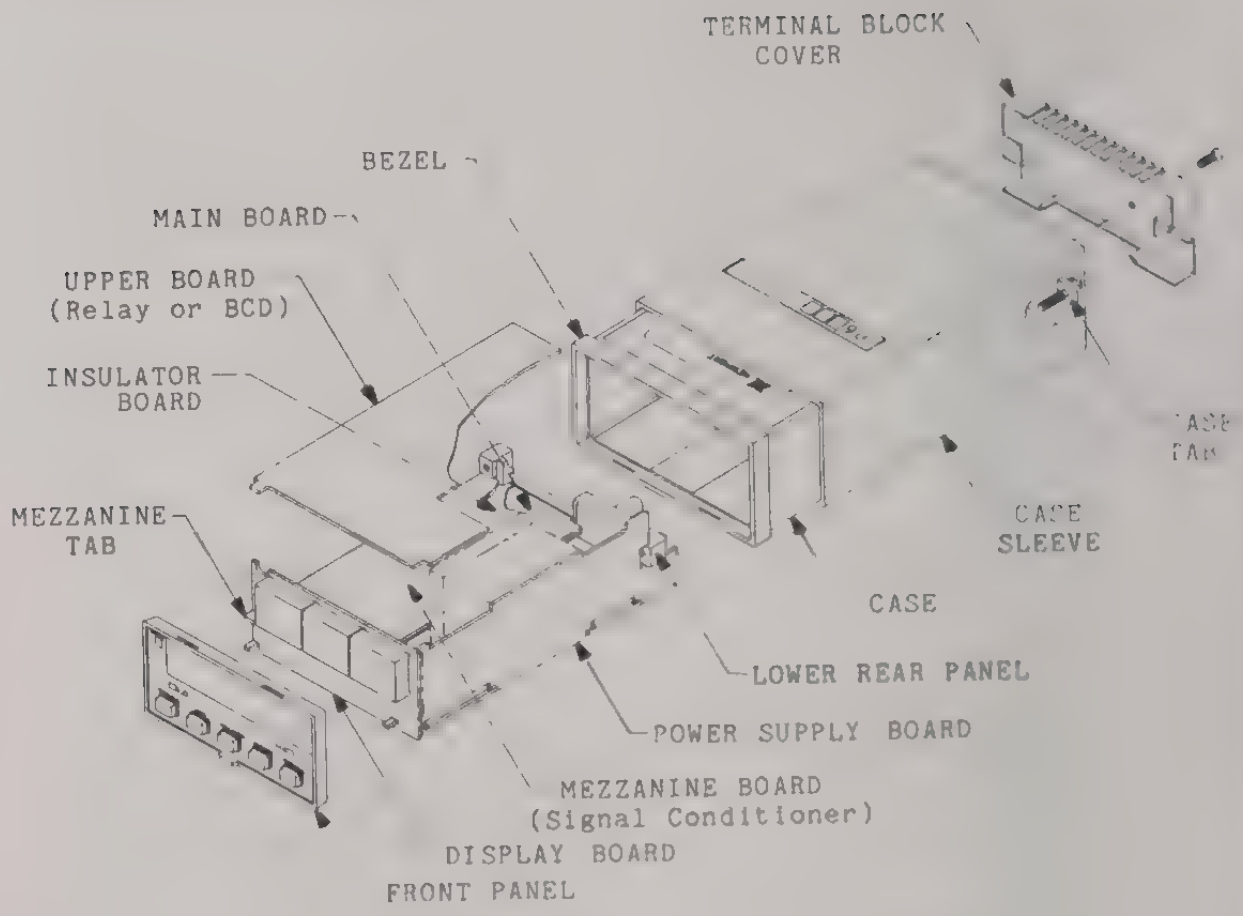


Figure 5-5 Exploded View of the P6000

5.6.1 Procedure

The P6000 is housed in a Newport [illegible] electronic circuitry can be installed or removed from the front of the is attached to the case with two [illegible] To install the P6000 on the panel, refer to the [illegible]

1. Install the insulator and signal conditioner boards if any:

   Refer to your signal conditioner [illegible] illustrations of the [illegible] insulator board into [illegible] the lower rear panel.

   Insert the tab of the signal conditioner [illegible] provided on the display board.

   Position J3, an 8-pin connector on the circuit side of the board, to mate with the P3 pins on the main board.

   Push the signal conditioner board [illegible] connector rests on the lower rear panel. [illegible] board).

2. Snap the upper rear panel onto the lower one so that it encloses the signal conditioner board.

3. Install the upper board (if any):

   Match the P5 pins on the upper board with the J5 connector on the power supply board and push downward. The board should rest on the upper rear panel.

4. Now slide the assembly into the case from the front until the rear panel touches the tabs at the rear of the case.

5. Verify the panel cutout dimensions from Figure 9-1 in the drawings section. Insert the case in the panel cutout from the front and slide the sleeve on from the rear. Install the two #8 screws to secure the sleeve to the case.

6. Connect all connectors and attach the terminal block cover.

7. Snap on the front panel (lens assembly).

5.7 CALIBRATION

The P6000 uses an 11.059 MHz crystal-controlled oscillator as a time base source. This frequency is stable within ±50 ppm over the full temperature range of 0 to 60°C. Although the frequency of the crystal may be ±100 ppm of the nominal frequency, the meter is factory-calibrated to within ±2 ppm at 25°C by setting the appropriate CALIBRATION VALUE before shipment. The calibration value is expressed in parts per million (ppm). For example, in the Frequency function, the reading can be increased by 999999 ppm (X 1.999999) and can be decreased -99999 ppm (X .900001). The calibration value has no effect in Frequency Ratio and Totalize functions since the crystal frequency doesn't affect those readings.

5.7.1 Procedure

Recalibration is possible with the following:

1. Set the function to Frequency, the Gate Time to 01.00 second and the calibration value to zero. Other setup parameters should be the same as the default setup (Table 2-1).

2. Connect a TTL-compatible calibration source frequency to the A input. SA jumper should be on the F position.

3. Note the displayed value and calculate the calibration value as follows:

$$CALib = 1{,}000{,}000 \times \left(\frac{\text{F input freq}}{\text{Display}} - 1\right)$$

4. Enter the calculated CALib and store it in the nonvolatile memory as described in Sections 4.10 and 4.11 .

Your P6000 is a powerful, universal counter with a wide range of programming parameters. An error in the programmed parameters can cause the counter to provide unexpected results. Before requesting service, please read this troubleshooting chart.

SYMPTOM	
Display Blank (completely)	Check the power connections. For battery-powered units, connect the BLANK ENABLE input (pin 16 of P2) to the GND. Push the two RECALL buttons simultaneously or turn off the power for 20 seconds.
Display shows the function, e.g., FrEq, and does not advance to show a measurement.	Check the input connections, levels, and jumpers (SA and SB). The input signal(s) may be missing. The Gate Time may be too long. The Internal Gate Time may be disabled (digit #6 of the Configuration Word 1). The External Gate Polarity may be reversed (digit #5, Configuration Word 1). $\overline{\text{HOLD}}$ input (pin 13 of P2) might be held low.
Display reads zero	Push the two RECALL buttons simultaneously. If display still reads zero: Use Auto-range. The scale factor may be a small multiplier (including zero) or a large divider. $\overline{\text{RESET}}$ input may be low.
Display shows an illegal character (not in glossary)	Push the two RECALL buttons simultaneously or turn off the power for 20 seconds.
Display in exponential format; e.g., 1.23 E6 (Overflow indication)	If the digit following the E is 5 or smaller, use the Auto-range. If it is 6 or greater, use a larger divide or smaller multiply scale factor and Auto-range.
One or more digits are flashing	The counter may be in the programming mode. Push the three center pushbuttons to reset the counter. If the display is still flashing, the measurement does not have enough accuracy for the selected resolution (range). Select Auto-range or reset digit #4 of Configuration 1 to zero (XXOXXX) to disable flashing of inaccurate digits.
Leading zeros are blank	Set the digit #1 of Configuration 1.
Leading zeros are not blank	Reset the digit #1 of Configuration 1.

Reading is incorrect.	Check the function, scale factor, offset, slope (in Time Interval only) and Calibration Factor.
Programming pushbuttons don't work.	Check the lock-out jumper S-8. $\overline{\text{RESET}}$ input might be held low.
Programming pushbuttons don't work properly.	Check the lock-out jumper S-7.
The least significant digit(s) bouncing.	The signal source may not be stable enough.
Display does not update.	The $\overline{\text{HOLD}}$ input (pin 9 of P1) might be held low. Inputs may be disconnected. Gate Time may be too long.

7.1 GENERAL

The P6000 contains a full-duplex RS-232 port for communications. It receives setup commands and data and sends measurement values and current setup data. It operates at either 1200 or 9600 baud, 7 data bits, even parity and 1 stop bit. It emulates DCE (data communication equipment) and uses a handshake line while sending data, but none while receiving data. A four-wire cable is the maximum required for communications:

Transmitted data
Received data
Request to send
Signal ground

When connected to a computer, such as an IBM PC, and one of four commands (Put, Get, Write or Read) is received, the P6000 interrupts its program, receives the message, takes appropriate action, and then starts over with a new measurement. No handshake is required because the P6000 devotes its full attention to receiving the command data from the computer.

In the other direction, the P6000 sends measurement and confirming setup data to the computer under handshake (RTS) control. When the computer RTS output is true, data is sent by the P6000. When it is false, data is not sent. There are two modes of handshaking when sending measurement data, message and character. In the Message Handshake mode, the P6000 checks the RTS input from the computer when it is ready to send measurement data. If the RTS is true, it sends the complete message data; if it is false, it skips sending the data completely and continues with the next measurement. In the Character Handshake mode, the program checks the RTS input before sending each character and does not continue with the next measurement until the current measurement has been completely sent.

7.2 ASCII OUT

The P6000 sends measurement data according to the following fixed formats of 12 characters (CnFG 2 SS6=0) or 9 characters (CnFG 2 SS6=1). Each character is sent as a 7-bit ASCII code character with even parity, and can be blank (ASCII 32) or as shown below:

12-Character message SS6=0 of CnFG 2

CHAR#	1	2	3	4	5	6	7	8	9	10	11	12
	H B or L	9 or -	9	9	.	9	9	9		H	Z	(CR)

9-Character message SS6=1 of CnFG 2

CHAR#	1	2	3	4	5	6	7	8	9
	H B or L	9 or -	9	9	.	9	9	9	(CR)

7.2.1 12-Character Format

In this format, the first character provides alarm information.

H = high alarm
L = low alarm
B = both high and low alarms
space = neither high nor low alarms

The next 7 characters represent the measurement value as displayed on the front panel. If positive, there are 6 digits and a decimal point; if negative, there is a minus sign with 5 digits and a decimal point. If leading zero suppression is selected, blanks are sent in place of leading zeros. If the value overflows the 6-digit limit, it is sent in exponential format up to a maximum of 9.99 E9 or -9.9 E9.

The next character is a space, followed by two units of measurement characters:

HZ	for frequency
MS	for period, time interval
2 spaces	for frequency ratio, totalize

The final character is a carriage return.

7.2.2 9-Character Format

The first 8 characters of this format are the same as in the 12-character format. The space and the units of measurement (or spaces) are omitted. The carriage return is the 9th character and indicates the end of the measurement. The 9-character format is used when a faster reading rate (and resulting shorter alarm response time) is more important than units of measurement.

7.3 SETUP DATA

When requested by the commands 'Get' or 'Read', setup data is sent to the computer for verification. Setup data is both sent and received as ASCII characters representing the sixteen hex characters 0-9, A-F. Each hex character represents four bits or 16 pieces of information. The 7-bit ASCII characters are shown with a leading even-parity bit.

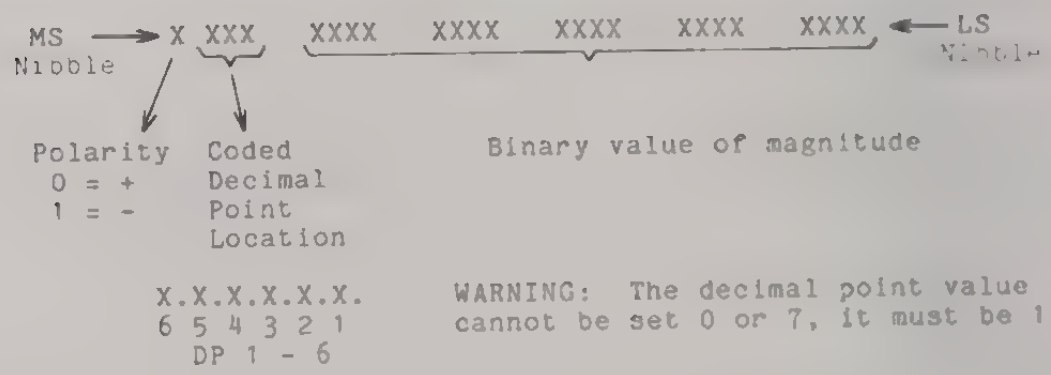
Hex Character	Bit Pattern	Hex Character	Bit Pattern
0	0011 0000	8	1011 1000
1	1011 0001	9	0011 1001
2	1011 0010	A	0100 0001
3	0011 0011	B	0100 0010
4	1011 0100	C	1100 0011
5	0011 0101	D	0100 0100
6	0011 0110	E	1100 0101
7	1011 0111	F	1100 0110

The setup data consists of a total of 42 nibbles of information that is sent and received in the following order:

P6000 Display	Parameter	# of Nibbles
CALIb	Calibration	6
SP HI	Setpoint High	6
SP LO	Setpoint Low	6
OFFSEt	Offset	6
SCALE	Scale	6
GAtE t	Gate Time	4
CnFG 2	Configuration 2	2
CnFG 1	Configuration 1	2
SLOPE	Slope	1
rAnGE	Range	1
Func	Function	2

Each parameter is sent with the most-significant nibble first. Each bit may have stand-alone significance or may be part of a binary number according to the following formats.

CALIB, SP HI, SP LO, OFFSET, SCALE (6 Nibbles Each)



WARNING: The decimal point value cannot be set 0 or 7, it must be 1 to 6.

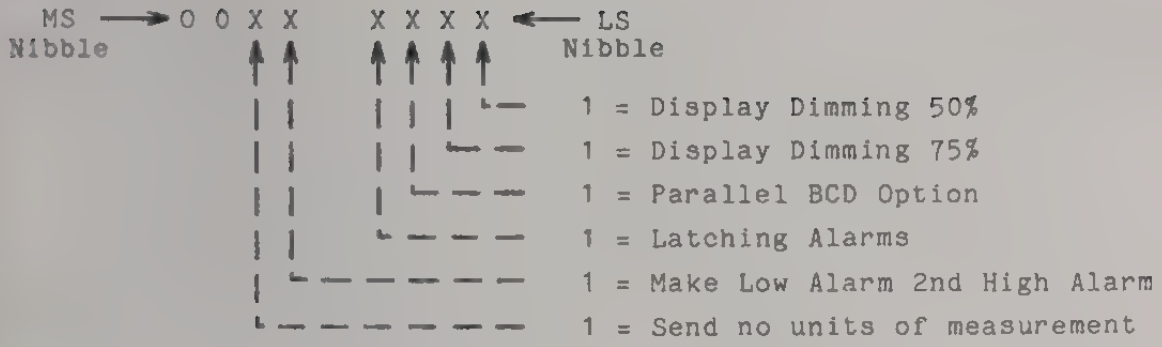
Example: A01000 = -0409.6
DP=2, - Polarity

GATE TIME

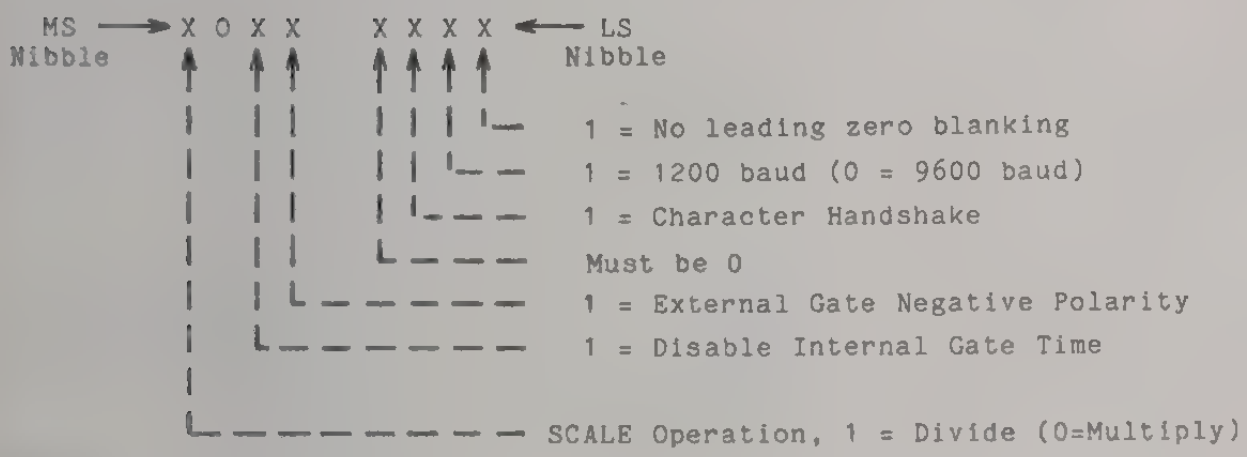
Binary value of magnitude in hundredths of seconds

Example: 0100 = 2.56 sec

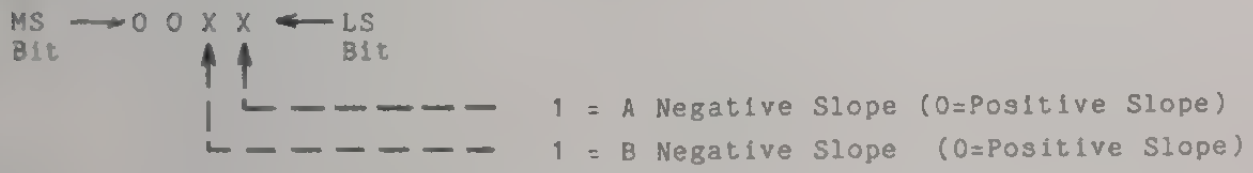
CONF 2


MS Nibble
0 0 X X
X X X X
LS Nibble
1 = Display Dimming 50%
1 = Display Dimming 75%
1 = Parallel BCD Option
1 = Latching Alarms
1 = Make Low Alarm 2nd High Alarm
1 = Send no units of measurement

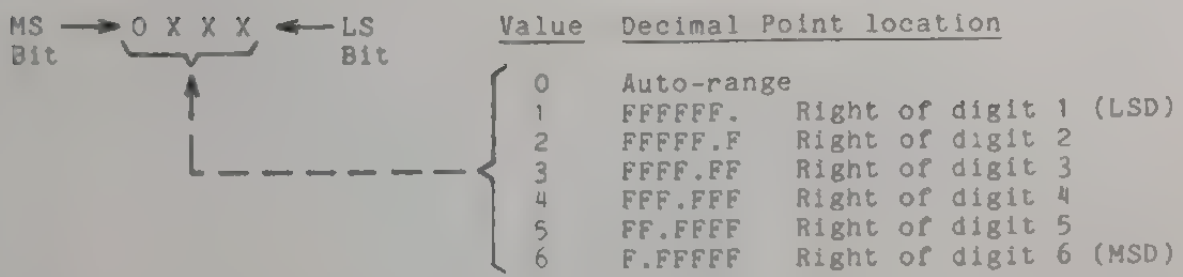
CONF 1


MS Nibble
X 0 X X
X X X X
LS Nibble
1 = No leading zero blanking
1 = 1200 baud (0 = 9600 baud)
1 = Character Handshake
Must be 0
1 = External Gate Negative Polarity
1 = Disable Internal Gate Time
SCALE Operation, 1 = Divide (0=Multiply)

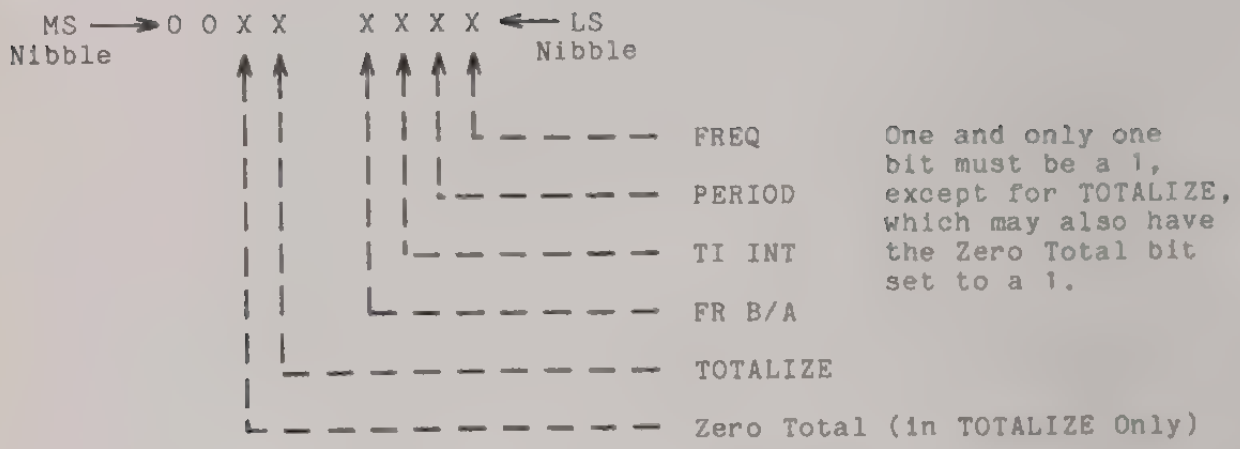
SLOPE



RANGE


MS Bit
0 X X X
LS Bit
Value
Decimal Point location
0 Auto-range
1 FFFFFF. Right of digit 1 (LSD)
2 FFFFF.F Right of digit 2
3 FFFF.FF Right of digit 3
4 FFF.FFF Right of digit 4
5 FF.FFFF Right of digit 5
6 F.FFFFF Right of digit 6 (MSD)

FUNC


MS → 0 0 X X
Nibble
X X X X ← LS
Nibble
FREQ
PERIOD
TI INT
FR B/A
TOTALIZE
Zero Total (in TOTALIZE Only)
One and only one bit must be a 1, except for TOTALIZE, which may also have the Zero Total bit set to a 1.

When received by the P6000 with the TOTALIZE bit, the Zero Total bit causes the value to be reset to zero; otherwise, the TOTALIZE value is unaffected.

7.4 ASCII INPUT

The P6000 receives commands and setup data. Four commands may be received: Put, Get, Write and Read. Each is a single letter preceded by the preamble string of three characters @U? . These characters have been selected to reduce the probability of noise patterns generating an acceptable command. The Put command is followed by 46 hex characters of desired setup data and all commands are terminated with a carriage return, indicated by (CR).

@ U?PXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX(CR)

@ U?G(CR)

@ U?W(CR)

@ U?R(CR)

The effect of the commands are described in the following paragraphs and in Figure 7-3.

7.4.1 'Put' Command @ U?P (setup data) (CR)

This command sends setup data to the P6000, which receives it into its active memory and then starts making measurements using the new setup parameters. This setup data is replaced by that in nonvolatile memory if the power is cycled off and on or the Reset pushbuttons activated.

7.4.2 'Get' Command @ U?G (CR)

This command requests the P6000 to send the current setup parameters in the active memory to the computer. It is normally used after the Put command to verify correct reception of the setup parameters by the P6000.

7.4.3 'Write' Command @U?W (CR)

This command transfers the setup data in the P6000 active memory (active program) to nonvolatile memory (stored program). If it is desired to have a different program active but not stored, this may be sent with a new 'Put' command or, if not locked out, entered from the keyboard. Setup data in nonvolatile memory is then transferred back to the active memory when power is cycled off and on or the Recall pushbuttons activated.

7.4.4 'Read' Command @U?R (CR)

This command requests the P6000 to read (transfer) the setup data in nonvolatile memory into the active memory for use in the measurements that follow and to send this setup data to the computer.

7.5 INTERFACING EXAMPLES

The P6000 can interface to any device with RS-232C communications. The output levels are ±5 V and the inputs may accept up to ±25 V. The pin connections are labeled for the P6000 to emulate DCE (Data Communications Equipment). Examples are given for connections to an IBM PC and to a Newport Model 821 printer.

	IBM PC (DTE) D-25 Connector	P6000 (DCE)	
Transmitted Data	2	P1-5	RS-232 IN
Received Data	3	P1-3	RS-232 OUT
Request to Send	4	P1-4	RS-232 RTS
Signal Ground	7	P1-9	GND

	IBM PC (DTE) D9 Connector	P6000 (DCE)	
Transmitted Data	3	P1-5	RS-232 IN
Received Data	2	P1-3	RS-232 OUT
Request to Send	7	P1-4	RS-232 RTS
Signal Ground	5	P1-9	GND
	1	P1-1	No Connection
	4	P1-7	No Connection
	6	P1-2	No Connection
	8	P1-6	No Connection
	9	P1-8	No Connection
	Do Not Connect	P1-10	0-20 mA

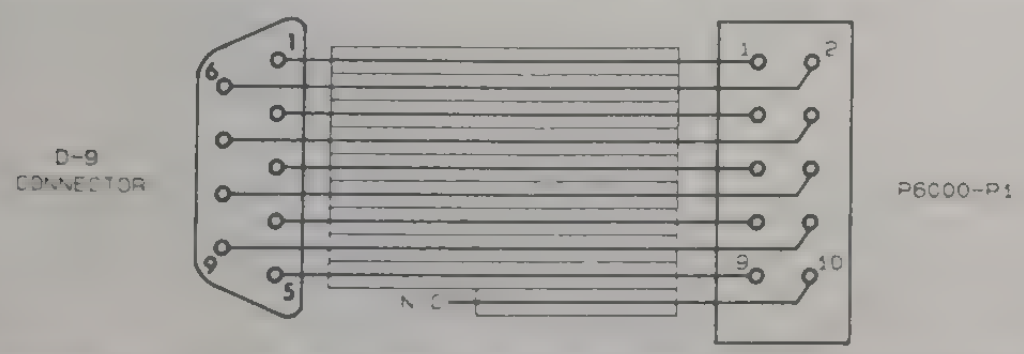


Figure 7-1 Ribbon Cable and Mass Termination to Connect P6000 Serial Port to IBM Computer with D9 Connector

See Programming Considerations, Section 7.6.2, for examples of IBM BASIC Program Statements for communications.

	NEWPORT MODEL 821 PRINTER (DTE)	P6000 (DCE)	
Received Data	3	P1-3	RS-232 OUT
Data Terminal Ready	20	P1-4	RS-232 RTS
Signal Ground	7	P1-9	GND

7.6 PROGRAMMING CONSIDERATIONS

7.6.1 Baud Rate

If possible, it is recommended that 9600 baud be used for communications instead of 1200 since a faster reading rate is achieved when less time is spent communicating. The time required to send measurements and receive setup data is:

	9600 baud	1200 baud
Measurements (12 characters)	12.5 ms	50 ms
Setup data (43 characters)	45.8 ms	183 ms

If the application program is to initiate communications with the P6000 and the initial baud rate setting of the P6000 is unknown, it is possible to write the application program to perform a test message at a trial baud rate and if that fails, change baud rate at the external device and try again. Once communications is established at the same baud rate, it may be changed by sending new setup data with the desired baud rate.

7.6.2 Communication Control Programming

The following statements written in IBM BASICA are suggested for inclusion in an application program written for the P6000.

1. CLOSE 1: OPEN "COM1:9600,E,7,1,RS,CS,DS" AS #1

This opens the IBM communications file for 9600 baud, even parity, 7 bit word and 1 stop bit. RTS is made false to begin with and the CTS and DSR handshake lines are ignored. Two stop bits could also be used but would only lengthen the communications time. If the IBM communications port is COM2, change COM1 above to COM2.

2. 3000 OUT &H3FC,INP(&H3FC) AND &HFD:RETURN

This subroutine resets the RTS output of the IBM to low (false). RTS false prevents the P6000 from sending readings.

3. 3100 OUT &H3FC,INP(&H3FC) OR &H02:RETURN

This subroutine sets the RTS output of the IBM to high (true). RTS true allows the P6000 to send readings.

4.
```
4000   IF LOC(1)=0 THEN 4030
4010   ON ERROR GOTO 4040
4020   A$=INPUT&(LOC(1),#1)
4030   ON ERROR GOTO 0:RETURN
4040   RESUME 4000
```

This subroutine empties the input buffer, and does it without a program-terminating error whenever the buffer is full. If the statement on line 4020 is executed by itself when the buffer is full, an error is generated.

5.
```
PRINT #1, '@U?P' + SETUP$
```

This sends the setup data of 42 hex characters in SETUP$ to the P6000.

6.
```
PRINT #1, '@U?G'
PRINT #1, '@U?R'
```

The first statement requests that the setup data be sent from the P6000 to the IBM computer. The second statement requests that the setup data be transferred from nonvolatile memory to active memory before being sent.

7.
```
PRINT #1, '@U?W'
```

This writes (transfers) data from the P6000 active memory to the nonvolatile memory.

8.
```
1000   GOSUB 4000              'EMPTY INPUT BUFFER
1010   B$=''''                 'HOLDS CUMULATIVE INPUT DATA
1020   GOSUB 3100              'MAKE RTS TRUE TO START
                                 P6000 SENDING DATA
1030   IF LOC(1)=0 THEN 1030   'WAIT FOR DATA
1040   A$=INPUT$(LOC(1),#1)    'GET DATA FROM INPUT BUFFER
1050   B$=B$+A$                'CONCATENATE CHARACTERS
1060   CR=INSTR(B$,CHR$(13))   'FIND LOCATION OF CARRIAGE RETURN
1070   IF CR=0  THEN 1030      'IF NOT RECEIVED YET, REPEAT
1080   A$=LEFT$(B$,CR-1)       'THE VALUE IS ALL CHARS UP TO
                                 THE CARRIAGE RETURN
1090   GOSUB 3000              'MAKE TRS FALSE TO STOP P6000
                                 FROM SENDING DATA
```

This reads the data sent from the P6000 to the IBM PC.

9. To read data continuously, add the following:
```
1100   B$=MID$(B$,CR+1)        'STRIP THE READING FROM THE
                                 STRING
1110   GOSUB XXXX              'DO SOMETHING WITH THE DATA IN
                                 A$
1120   GOTO 1020               'READ MORE DATA
```

7.7 PARITY CHECKING

Although the P6000 includes an even parity bit with data sent out on the RS-232C interface, it does not check the data received for even parity.

7.8 TIMING

When a Put command is sent to the P6000, it is accompanied by a string of 42 setup characters. The statement PRINT #1, @U?P + SETUP$ puts the string into an output buffer for transmission and the BASIC program continues while the data is being transmitted. If within a few lines, the statement PRINT #1, @U?G is executed, the @U?G is added to the end of the setup string in the buffer which is still being transmitted. This causes the @U?G characters to be missed because each transmission from the computer must be completely received by the P6000 and the next measurement started before another command is issued. A statement FOR J=1 TO 300:NEXT J introduces enough delay to allow separation between commands.

7.9 MODEM OPERATION

The P6000 can be connected to a freestanding modem, such as the Hayes Smartmodem 1200, so that data can be transmitted and received over phone lines. A typical controller would be an IBM PC with a Hayes Smartmodem 1200B plug-in modem.

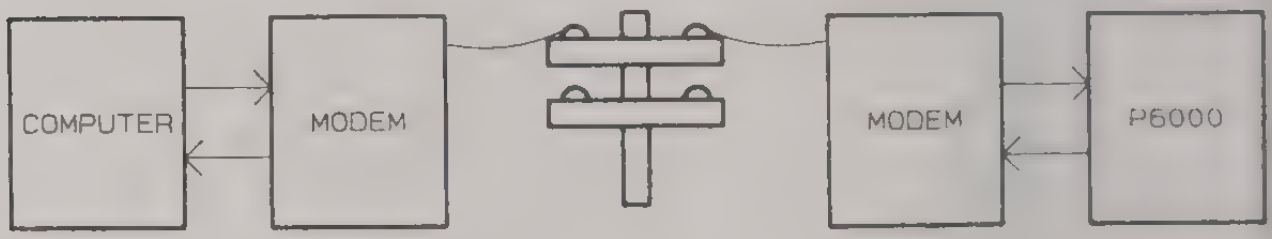


Figure 7-2 Modem Concept

Using a rate of 1200 baud, measurement data can be received by the computer from the P6000 and setup data can be sent to the P6000 from the computer. By using an auto-answering modem connected to the P6000, data can be gathered from a remote location upon demand. If a command is sent to the P6000 at 1200 baud while the P6000 setup memory is programmed for 9600 baud, the P6000 will automatically switch to 1200 baud. This prevents the modem application from being disabled when a setup parameter of 9600 baud is accidentally sent to the P6000.

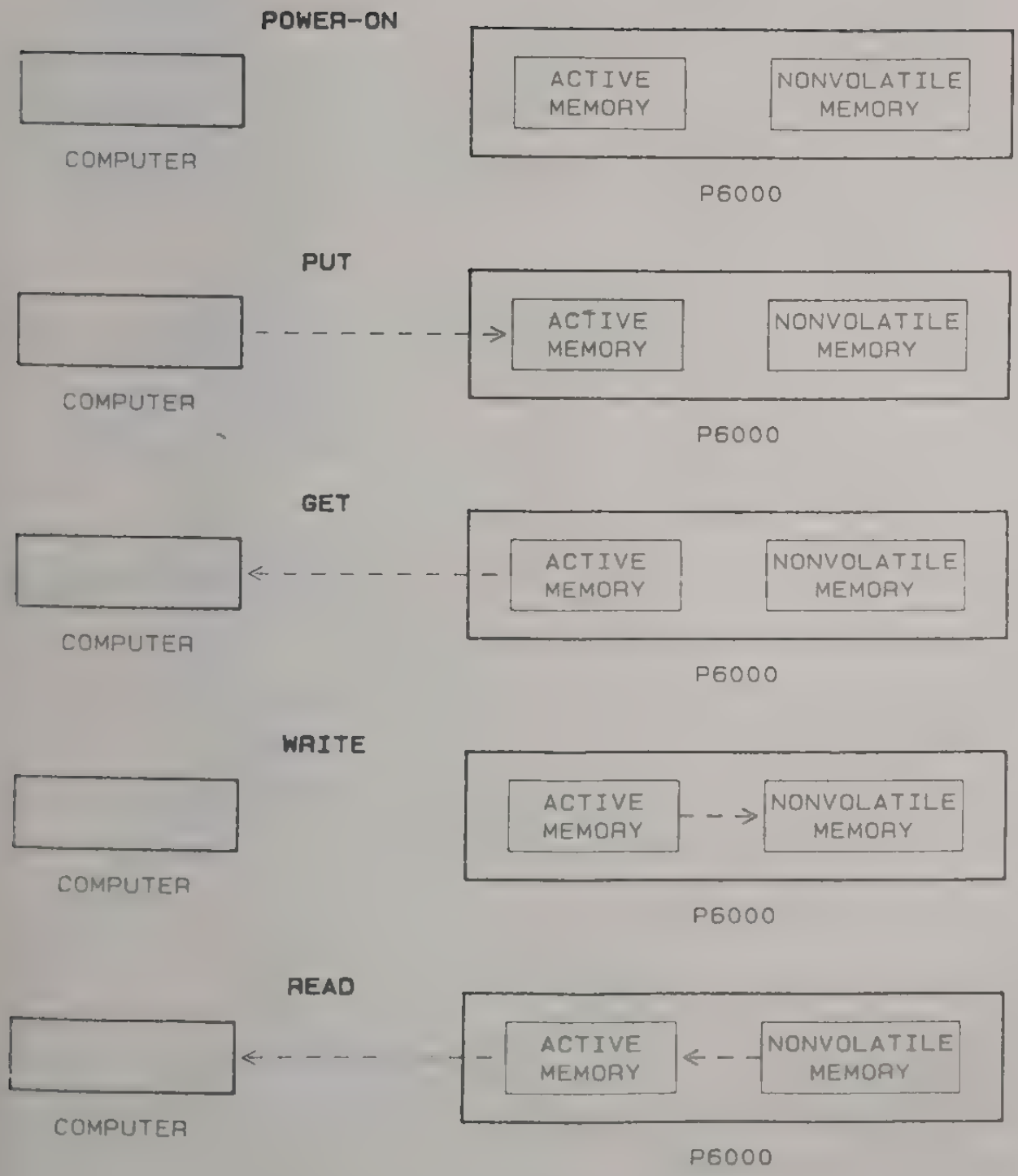


Figure 7-3 Programming Commands

8.1 GENERAL

Programmable Functions:	Frequency, Period, Time Interval A to B, Frequency Ratio B/A, Totalize
Scale Factor:	-99999 to 999999 with a choice of six decimal point positions (9.9.9.9.9.9.), multiply or divide
Offset:	-99999 to 390000 with a choice of six decimal point positions (9.9.9.9.9.9.)

8.2 INPUT CHARACTERISTICS

Max Frequencies (A and B inputs square wave, 0 to +5 V):	SA and SB on F positions: 7 MHz (minimum) SA and SB on M positions: 200 kHz (typ) SA and SB on S positions: 3 kHz (typ)
Trigger Slopes (A and B):	Positive or Negative, programmable
Input Threshold:	All TTL and CMOS compatible except spare flip-flop inputs, which are: 5 V, CMOS compatible (Low = less than 0.9 V, High = more than 3.5 V)
Input Impedance:	A, B and External Gate inputs: 20 k pull-up $\overline{\text{HOLD}}$ input: 100 k pull-up (typ) $\overline{\text{RESET}}$ input: 10 k pull-up
Max Input Voltage : (A and B)	SA and SB on F positions: -0.5 and +5.5 V SA and SB on M or S positions: -20 and +25 V
Max Input Voltage : (all other inputs)	-0.5 and 5.5 V

8.3 DISPLAY

Type:	7-segment, orange LED with red lens
Digit Height:	14.2 mm (.56 in)
Symbols:	-.8.8.8.8.8. and 8.8.8.8.8.8.
Decimal Point:	Six positions; programmable Fixed or auto-ranging
Leading Zeros:	Blank or displayed; programmable
Overflow Indication:	Display in exponential format to 9.99 E9

Update Time:	Averaging time + (10-40 milliseconds) + communication time
Brightness:	100%, 50%, 25%; programmable
Displayed Value:	(Measurement . Scale Factor) + Offset
Indicator Lights:	GATE LED; Low and High alarm LEDs
Capacity:	
decimal format	-99999 or 999999
exponential format	-9.9×10^9 or 9.99×10^9 Where: offset = zero, scale = negative & offset = positive, or scale = positive & offset = negative
	1.66×10^7 Where: offset ≠ zero or scale and offset have the same sign

8.4 OUTPUT CHARACTERISTICS

Lo, Hi and Go Alarm Outputs:	Open-collectors, active low, 150 mA at 1 V
Digit 6:	High level = 3.5 V at 100 µA Low level = 0.4 V at 1.6 mA Frequency = 400 Hz ±.1%

8.5 TIME BASE

Internal Clock Reference:	11.059 MHz
Stability:	±50 ppm over 0-60°C range
Fine-Calibration method:	Programmable calibration value
Calibration accuracy at 25°C:	±2 ppm

8.6 COMMUNICATION

RS-232 OUT, IN and RTS:	RS-232 C compatible with transmit handshake line (RTS)
	Levels: ±5 V
Transmitted data:	Alarm + 6 digits + decimal point + CR (9 characters)
or	Alarm + 6 digits + d.p. + space + units of measurement + CR (12 characters)
Baud rate:	1200 or 9600 baud, programmable
Received data:	Complete setup parameters, no handshake
20 mA ASCII out:	Open collector (data the same as RS-232 OUT)
Bit serial BCD (Internal connection to Parallel BCD board):	32 bits: display and alarm data. When enabled, takes about 10 milliseconds to be transmitted.

8.7 FREQUENCY/PERIOD FUNCTION

Frequency range:	10-6 Hz to 7 MHz (140 nsec to 36 days)
Nominal Gate Time (NGT):	00.00 to 99.99 seconds
Averaging Time (Actual Gate Time):	(NGT + 2.7 ms) or Ext. Gate Time + time to complete the last period
Max Ext. Gate Time:	$\frac{6 \times 10^{10}}{F_A}$ or 36 days, whichever is less
Units-of-Measurement (Scale Factor = 1):	Frequency: hertz Period: milliseconds
Accuracy at 25°C: (Auto-range SA on F Position)	±1 LSD ±2 ppm of input
Calculation time:	Scale Factor is a multiplier; 20-35 ms Scale Factor is a divider; 30-45 ms
Max speed (gate time minimum) (Parallel BCD disabled, RTS false):	20-40 readings/second

8.8 TIME INTERVAL

Interval range, A to B:	400 ns to 36 days
Trigger error (A - B):	SA and SB on F positions: +30 ±70 ns SA and SB on M positions: +30 ±250 ns SA and SB on S positions: ±9 ns
Accuracy, NGT = 00.00:	±1 LSD ± trigger error ± TI (Time Base Error)
Accuracy, NGT ≠ 00.00:	±1 LSD ± trigger error ± TI (Time Base Error) / $\sqrt{N}$ where N is number of averaged intervals.
Number of averaged intervals:	N = Averaging Time / 2
Nominal Gate Time, NGT:	[illegible]
Averaging time:	NGT = 00.00: .1 ms + time to complete the last interval NGT ≠ 00.00: NGT + 2.5 ms + time to complete the last interval
Averaging method:	Every other Time Interval
Unit of Measurement: (Scale Factor = 1)	milliseconds

8.9 FREQUENCY RATIO, $\frac{B}{A}$

B input frequency range:	0.007 Hz to 7 MHz
A input frequency range:	F_B > 5 kHz: 10-6 Hz to 7 MHz F_B < 5 kHz: $\frac{1}{F_A} + \frac{1}{F_B} < 160$ sec
Nominal Gate Time (NGT):	00.00 to 99.99 seconds, in .01 sec steps
Averaging time:	(NGT + 2.5 ms) or Ext. Gate Time + time to complete the last period of A and B
Accuracy: (SA and SB on F positions)	F_B > 5 kHz: ±1 LSD $\pm^{(\text{averaging time})} \times (F_B)$ F_B < 5 kHz: ±1 LSD ± 5000 (averaging time)
Max External Gate Time:	$\frac{6 \times 10^{13}}{F_A}$ or $\frac{3.5 \times 10^{10}}{F_B}$, whichever is less

8.10 TOTALIZE

Count direction:	Up or Down (determined by sign of scale factor)
LSD: (Auto-range, Scale Factor=1)	1 count of the input
Internal count capacity:	6×10^{10} counts
AC power failure provisions:	Display value stored in nonvolatile memory and restored with power

8.11 POWER

+5 V output:	Regulated, 50 mA max in non-totalize modes (1) (reduced by upper-board option)
V+ output:	Unregulated, 6-9 V, 50 mA max in non-totalize modes (1) (reduced by upper-board option and current drawn from the +5 V output)
AC voltage (standard):	115 or 230 V ac ±10% 47 to 400 Hz
Power consumption:	3 W, typical
Battery backup: (connected to V+ with a diode)	6-12 V, 50 mA (typ), without upper-board option

NOTE: In totalize mode, 20 mA can be drawn from +5 V or V+ when display brightness is normal or dim (CnFG 2 = XXXXX1). Up to 50 mA can be drawn if the BLANK ENABLE input is tied to GND. This prevents a power failure detection.

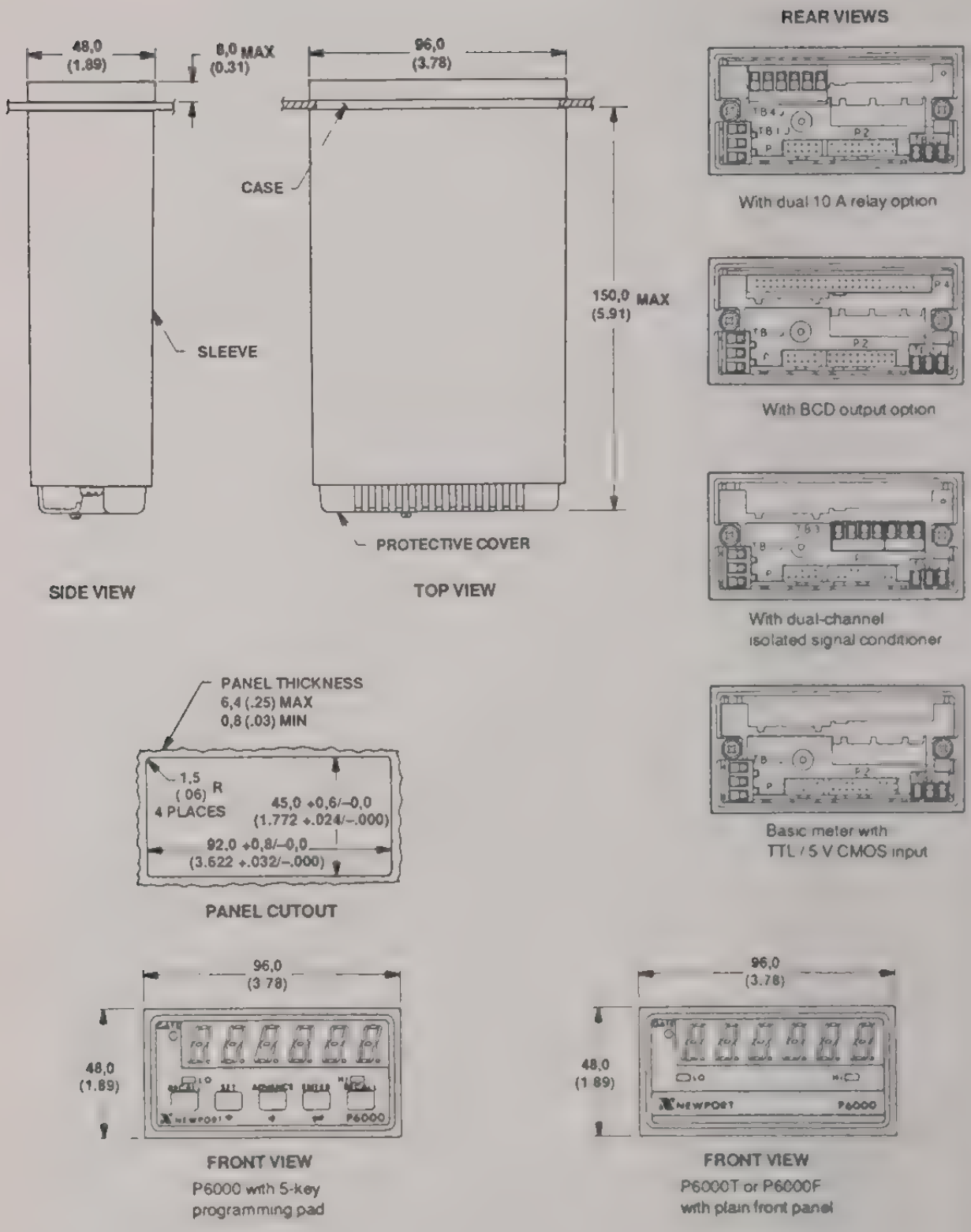


Figure 9-1 Case Dimensions

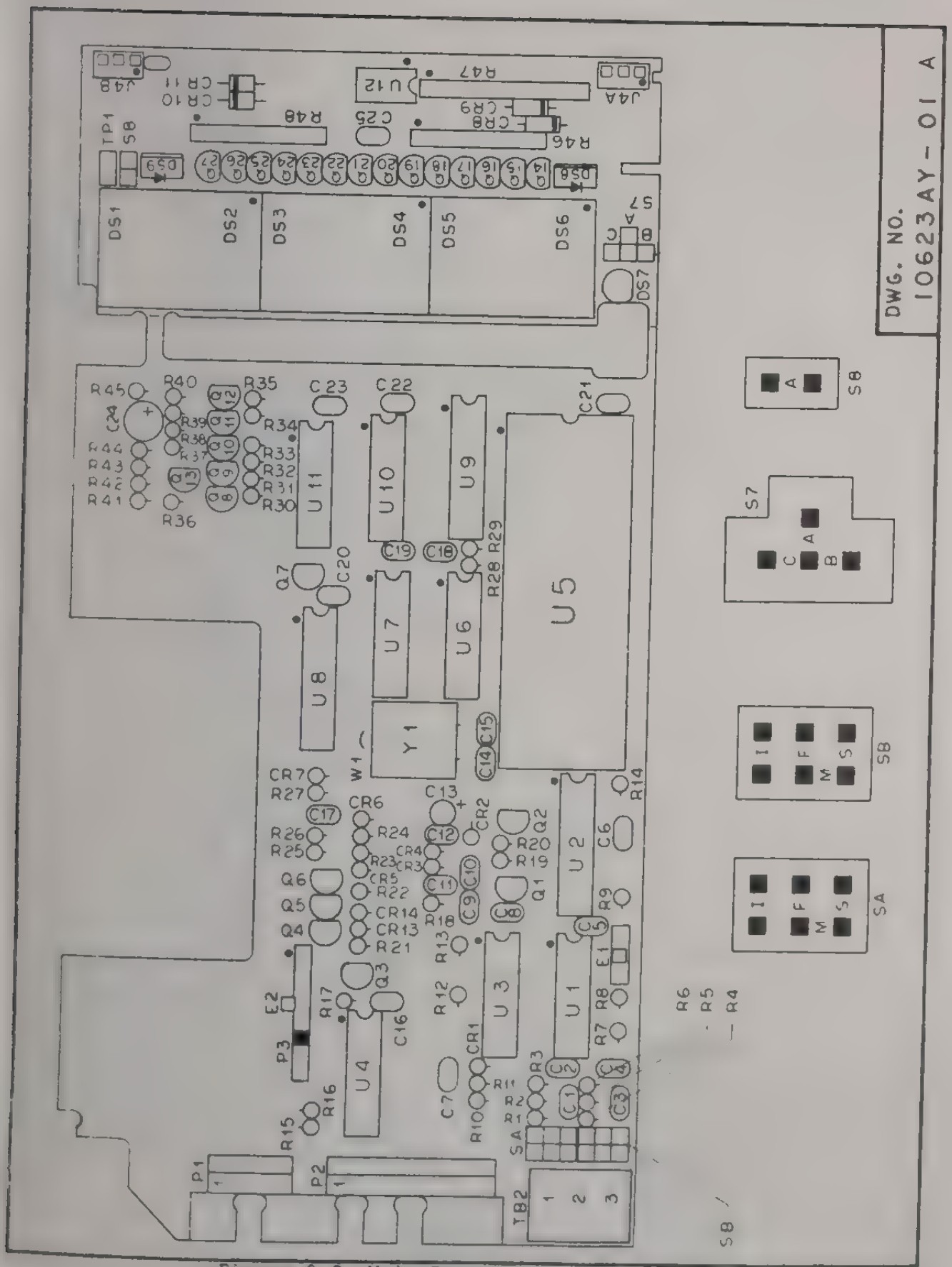


Figure 9-2 Main Board Assembly Diagram

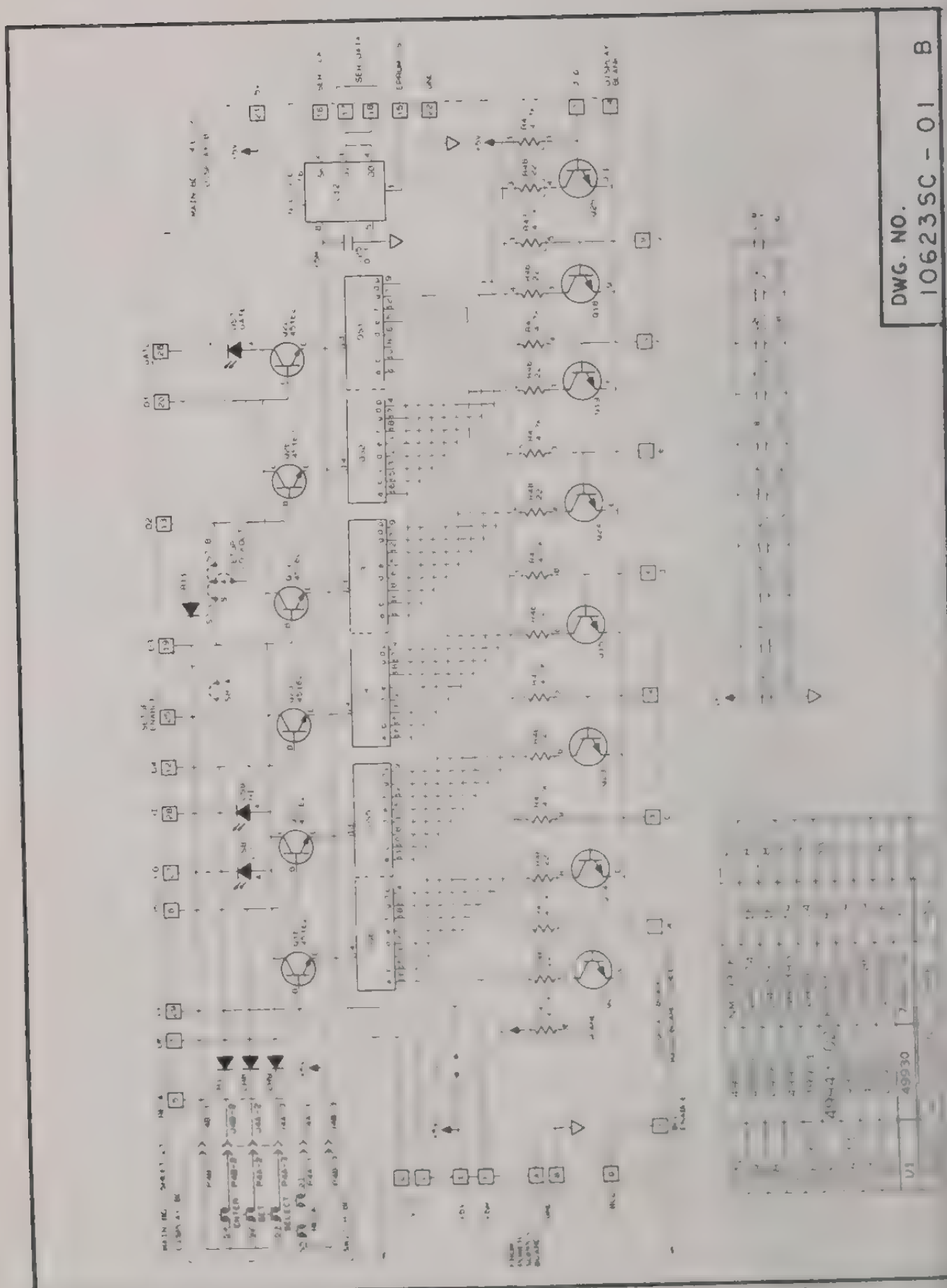


Figure 9-3 Main Board Schematic Diagram (1 of 2)

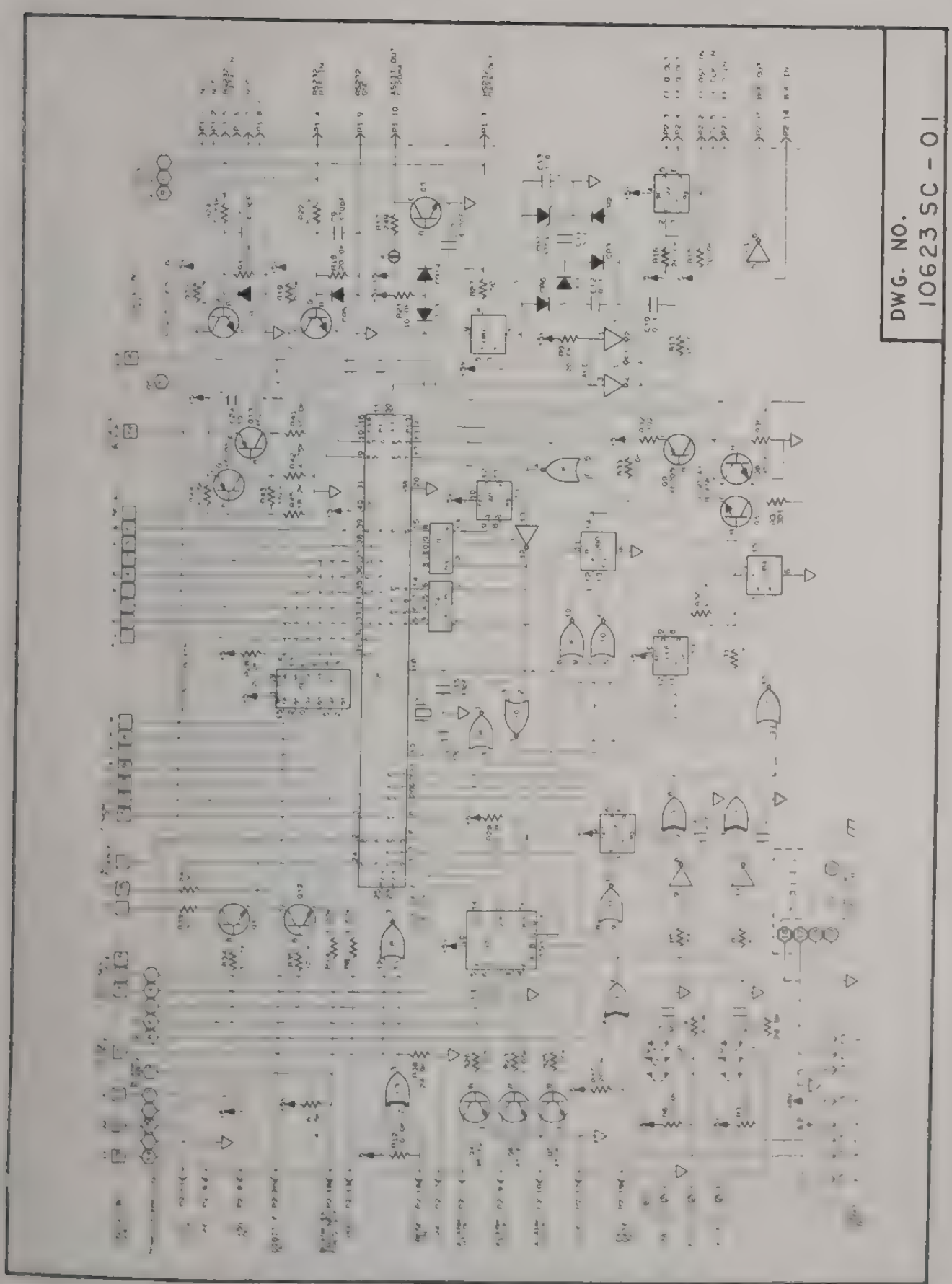


Figure 9-4 Main Board Schematic Diagram (2 of 2)

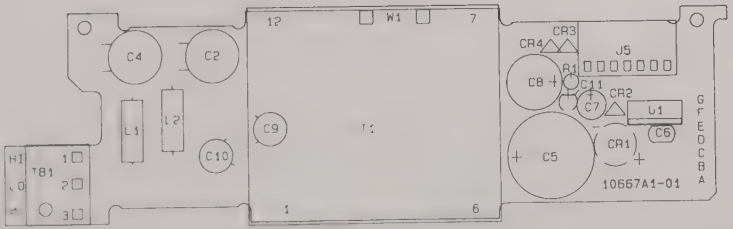


Figure 9-5 AC Power Supply Assembly Diagram

DWG.NO.
10667AY-02 A

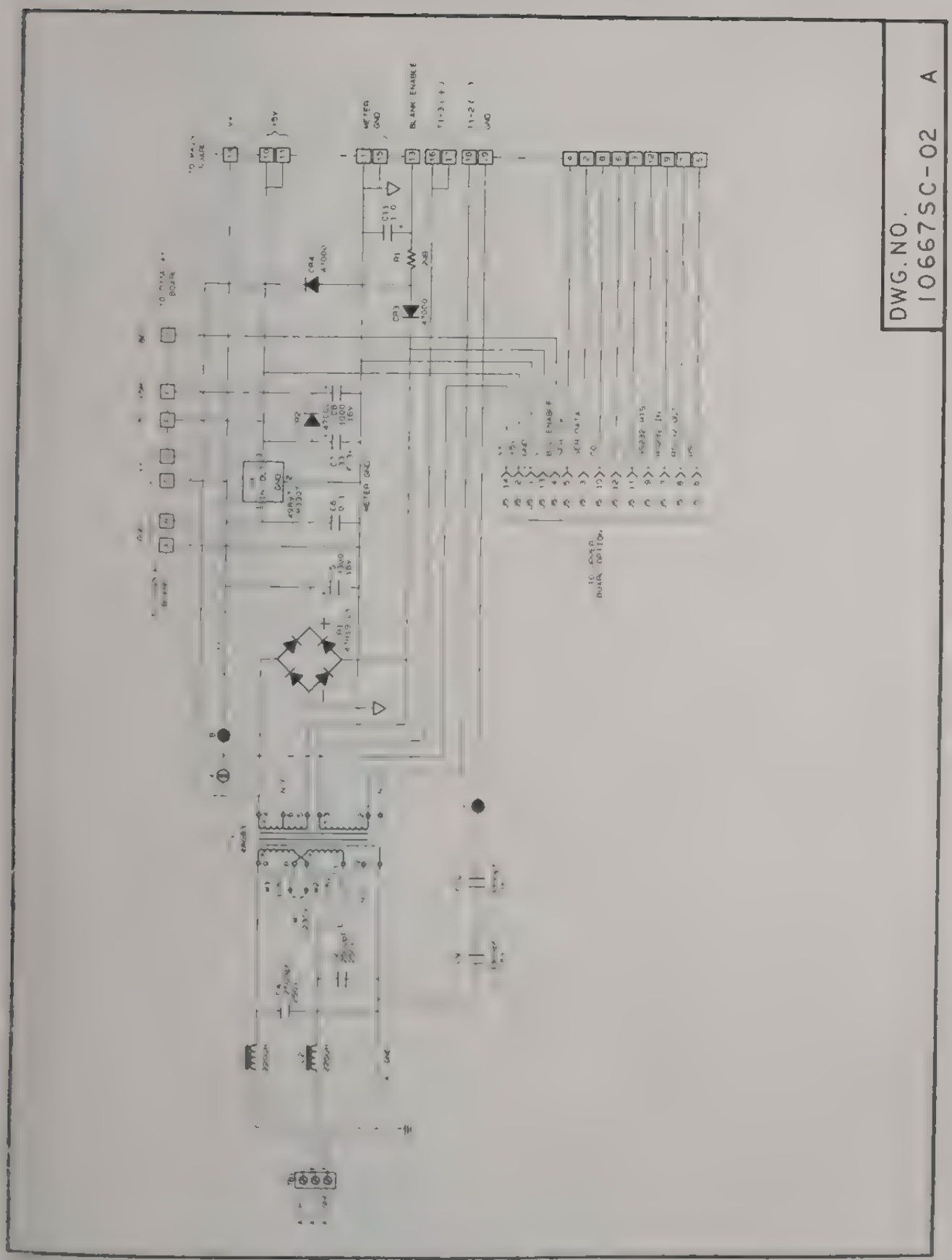


Figure 9-6 AC Power Supply Schematic Diagram

DWG. NO.
10668AY-01 A

Figure 9-7 DC Power Supply Assembly

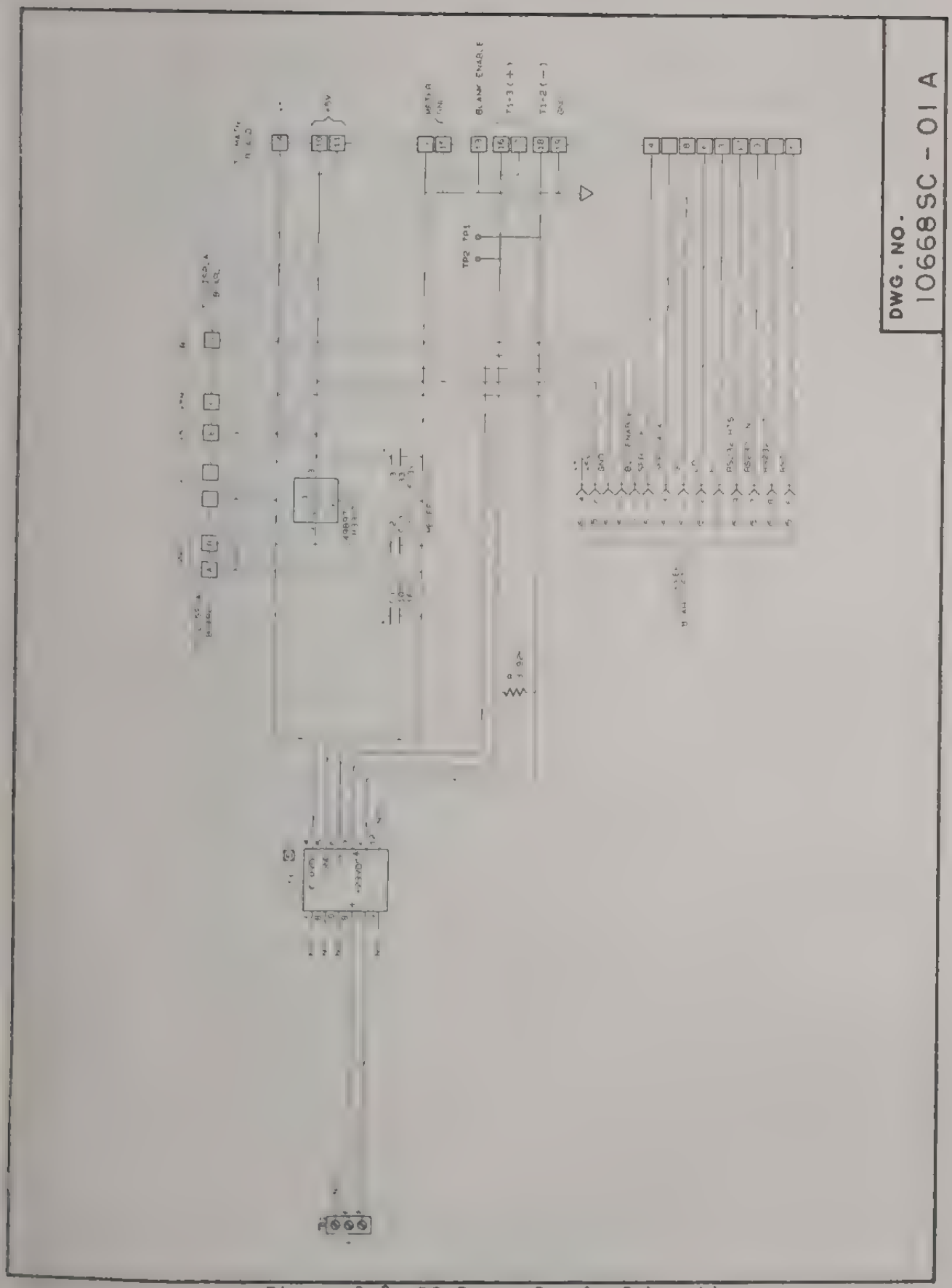


Figure 9-8 DC Power Supply Schematic

THEORY OF OPERATION

FREQUENCY AND PERIOD

To display the input frequency in Hz, a conventional counter simply counts the input pulses (cycles) during a 1-second gate time and displays the result without any change. The P6000 counts both the input pulses and the internal clock pulses during a programmable gate time and calculates the frequency. As a result, the display resolution is not limited by the input frequency. One-tenth of a second of gate time is enough for 6-digit resolution. (Figure A-1 compares the resolution of a conventional counter with .1 second gate time with the P6000 resolution.)

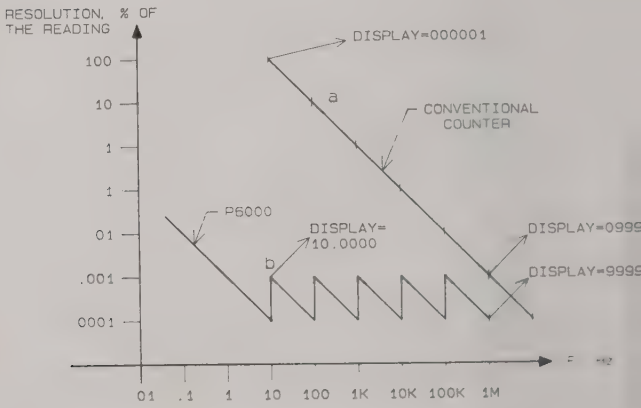


Figure A-1 Resolution Comparison of P6000 to Conventional Counters

Gate Timing:

The P6000 starts a frequency/period measurement by arming the A flip-flop. Then, the first trigger slope of the A input sets this flip flop and opens the A and B gates, permitting the input pulses and the 11.059 MHz internal clock to be counted by the A and B counters, respectively. After the gate time is over, the P6000 disarms the A flip-flop, and the next trigger slope of the input resets the flip-flop and closes the A and B gates. At this time, the P6000 reads the A and B counters and calculates the frequency or period.

$$\text{Frequency} = \frac{\text{Number of Input Pulses}}{\text{Averaging Time}} = \frac{\text{Counter A}}{\text{Counter B/Clock Frequency}}$$

$$\text{Frequency, Hz} = \frac{\text{Counter A}}{\text{Counter B}} \quad (11.059 \times 10^6) \left(\frac{\text{Calibration Value}}{1000000} + 1 \right)$$

$$\text{Period, ms} = \frac{1000}{\text{Frequency, Hz}}$$

When using an external gate time, the timing is the same except that after arming the flip-flop, the P6000 waits until the external gate signal disarms the flip-flop and the next input pulse closes the A and B gates. Burst Frequency Measurement is possible using the external gate input without disabling the internal gate. The timings are shown below in Figure A-2.

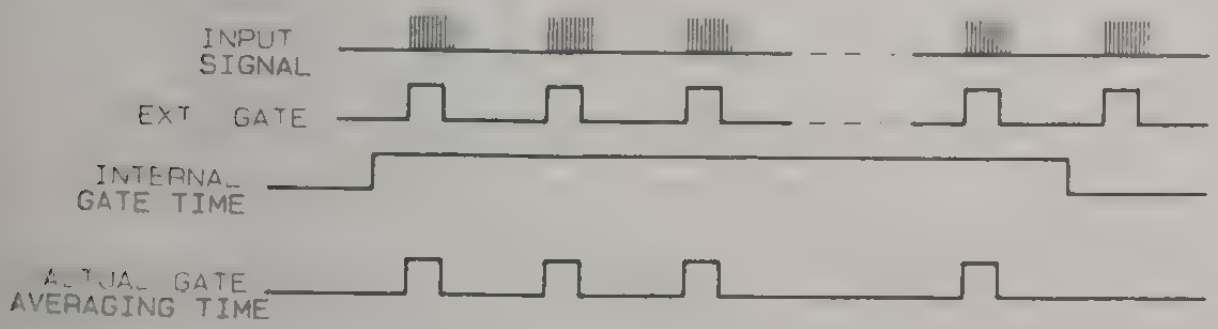


Figure A-2 Burst Frequency Measurement

The external gate signal must be active only when the input signal is valid.

TIME INTERVAL MEASUREMENT (A TO B)

The P6000 measures the time interval from the trigger slope of the A input to the trigger slope of the B input and displays the result in milliseconds. If the Nominal Gate Time is long enough, the P6000 averages a number of time intervals. This helps to improve the accuracy by /N, where N is the number of measured intervals (every other interval is measured).

$$\text{Display Resolution} < \frac{1}{11059\ (\text{Time Interval in milliseconds})\ \sqrt{N}}$$

Gate Timing:

The measurement is started by arming the A flip-flop. The trigger slope of the A input then sets the A flip-flop. This opens the A and B gates and arms the B flip-flop. The next trigger slope of the B input sets the B flip-flop and this resets the A flip-flop and closes the A and B gates. If the Nominal Gate Time is long enough, the second trigger slopes of the A and B inputs reestablish the original condition and the next pair of (third) trigger slopes opens and closes the gate again.

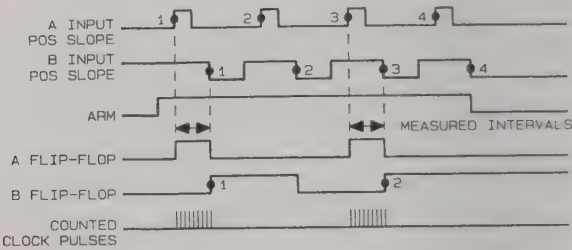


Figure A-3 Time-Interval Timing Measurement

The A counter counts the number of intervals averaged (B flip-flop output), and the B counter counts the internal clock pulses during the averaged intervals.

FREQUENCY RATIO

When the B input frequency is greater than 5 kHz, frequency ratio measurement is done similar to the frequency measurement, except that the B counter counts the B input pulses, instead of internal clock pulses. The display resolution is determined by the B input frequency and the averaging gate time (Auto-range, Scale = 1).

$$\text{Display Resolution} = \frac{1}{F_B \cdot (\text{Averaging Time})}$$

Where: Averaging Time = Nominal Gate Time + 2.5 ms + time to complete the last A and B cycles.

Gate Timing:

The measurement is started with the arming of the A flip-flop. The selected trigger slope of the A input then sets the A flip-flop. This arms the B flip-flop and opens the A gate. Now the selected trigger slope of the B input opens the B gate. At the conclusion of gate time, the P6000 disarms the A flip-flop. Then the next A pulse closes the A gate and the next B pulse closes the B gate. While the respective gates are open, the A and B input pulses are counted by the A and B counters. The P6000 then reads the A and B counters and calculates the frequency ratio.

$$\text{Display} = \left(\frac{\text{Counter B}}{\text{Counter A}}\right) (\text{Scale Factor}) + \text{OFFSET}$$

It should be noted that, because the scale factor and offset can be negative numbers, it is possible to display $K.\frac{B-A}{A}$ (or $K.\frac{A-B}{A}$) since

$$K.\frac{B-A}{A} = K\left(\frac{B}{A} - 1\right) = \frac{B}{A} \cdot K - K = \begin{array}{l}\text{Scale Factor} = K \\ \text{OFFSEt} = -K\end{array}$$

When the B input frequency is less than 5 kHz, the P6000 interpolation method achieves much greater accuracy than conventional counters. This feature makes the P6000 very useful in low frequency ratio measurements.

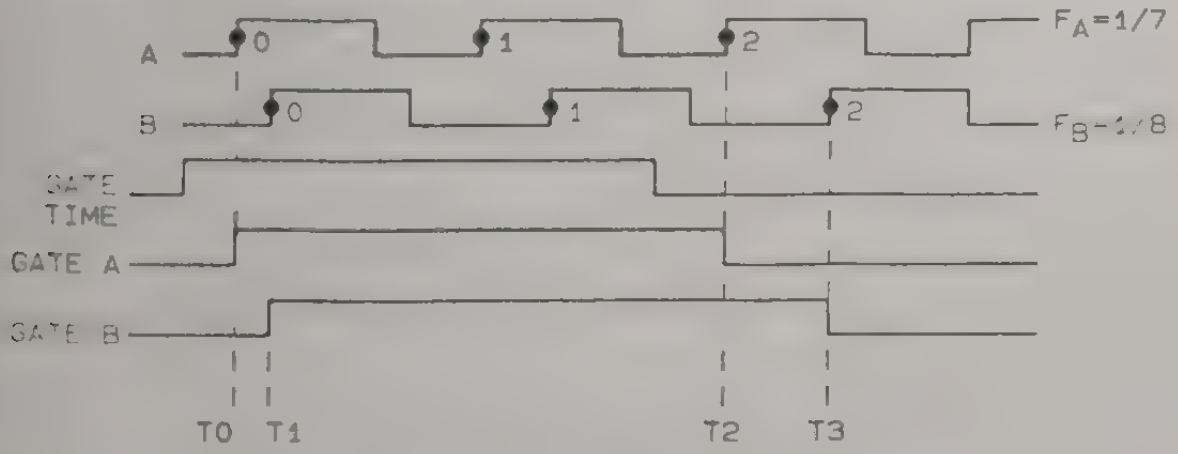


Figure A-4 Frequency-Ratio Timing Measurement

$$\text{Display} = \left(\frac{\text{Counter B}}{\text{Counter A}} \cdot \frac{T2-T0}{T3-T1} \right) (\text{Scale Factor}) + \text{OFFSET}$$

For the above waveforms and scale factor = 1, OFFSET = 0 :

$$\text{Display} = \frac{2}{2} \cdot \frac{14}{16} = \frac{7}{8}$$

When the B input frequency is less than 5 kHz, the display resolution is determined by the Averaging Time only.

$$\text{Display Resolution} = \frac{1}{5000 \cdot (\text{Averaging Time})}$$

The timer that records the T0, T1, T2 and T3 times has 160 seconds capacity, so when measuring the ratio of very low frequencies, the total measurement time should not exceed 160 seconds.

TOTALIZE

Totalize is started by arming the A flip-flop. Then the first trigger slope of the A input sets the A flip-flop and opens the Gate. This allows the A input pulses to be counted by the A counter. The P6000 reads the A counter and adds one count to it if Gate A is open, so that the number of A input pulses is displayed. This method of gating allows the input pulses to be repeatedly gated by an external signal (on the external gate input) without any error.

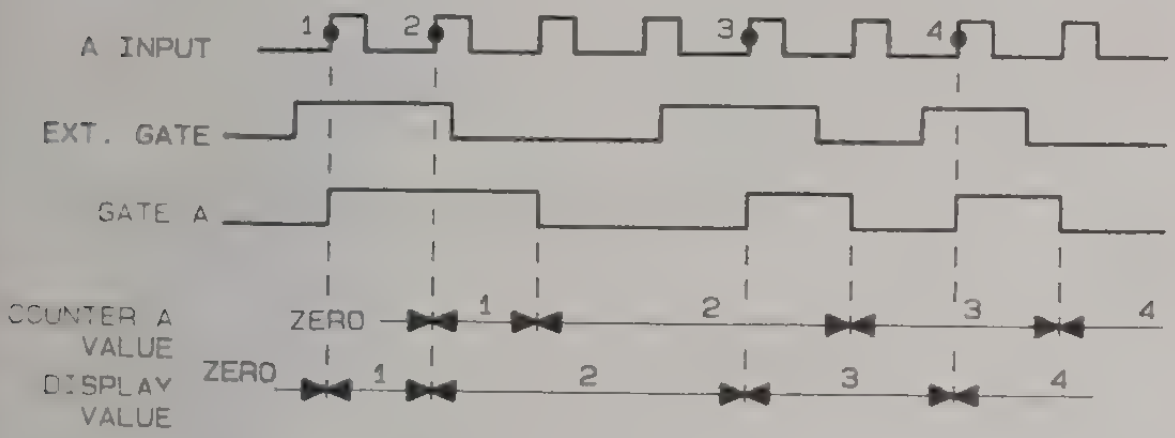


Figure A-5 Timing in Totalize Function

It should be noted that the display value and the alarm outputs status lag the input pulses by 0-25 milliseconds (calculation time) plus the communication time. This delay cannot be seen on the display but when using the alarm outputs for control purposes, it may be desired to reduce this delay as much as possible. This **display update time is minimized by:**

1. Disabling the parallel BCD data, if not used (sending data to the **parallel BCD board takes about 10 milliseconds);**

2. Disabling the RS-232 output by leaving RTS open or false. (The RS-232 output takes about 13 milliseconds at 9600 baud);

3. Using a multiplier scale factor (a divider scale factor lengthens **the calculation time about 10 sec).**

With these provisions, the display update time is reduced to 8-15 milliseconds in totalize and 20-30 milliseconds in other functions.

SYMBOL	DESCRIPTION	OTHER POSSIBLE SETTINGS
A .SC	Scale Factor is a MULTIPLIER Display = (measurement · scale) + offset	A/SC
A/SC	Scale Factor is a DIVIDER Display = (measurement/scale) + offset	A .SC
A nEG	A input trigger slope is NEGATIVE (counting negative edges)	A POS
A POS	A input trigger slope is POSITIVE (counting positive edges)	A nEG
Auto	Auto-ranging is selected. The P6000 selects the decimal point.	FFFFFF., fixed range with one of the six available decimal points
b nEG	B input trigger slope is NEGATIVE (counting negative edges)	b POS
b POS	B input trigger slope is POSITIVE (counting positive edges)	b nEG
CALIb	CALIBRATION value, expressed in parts per million	-99999 to 999999 ppm with six possible decimal pt positions
CnFG 1	CONFIGURATION 1, set of six software switches, SS1-SS6.	6 digits, each can be 0 or 1 to disable or enable a feature.
CnFG 2	CONFIGURATION 2, set of six software switches, SS1-SS6.	6 digits, each can be 0 or 1 to disable or enable a feature.
FFFFFF	FIXED RANGE, with selected decimal point flashing.	Auto. Auto-ranging
Fr brA	P6000 function is FREQUENCY RATIO B/A (B input is divided by the A input)	FrEq, PEriod, ti Int, totAl
FrEq	P6000 function is FREQUENCY (Measures the A input frequency)	PEriod, ti Int, Fr brA, totAl
Func	Operating FUNCTION	Available functions are: Frequency, Period, Time Interval, Frequency Ratio and Totalize

Table B-1 Glossary of Symbols and Terms

GAtE t	Nominal GATE TIME, the averaging time that determines the display update rate.	The value ranges from 00.00 to 99.99 seconds, with a fixed decimal point.
OFFSEt	OFFSET (Preset) (Display = (Input x Scale) + Offset.	Ranges from -99999 to 390000 with a programmable decimal point.
PEr1od	P6000 function is PERIOD	FrEq, t1 Int, Fr brA, totAL
rAnGE	RANGE	Can be set to Auto-range (Auto) or a fixed decimal point can be selected (F.F.F.F.F.F.)
SCALE	SCALE Factor	Ranges from -99999 to 999999 with a programmable decimal point. Multiply or divide.
SLOPE	Trigger SLOPE of the Input(s)	Positive or negative slopes can be selected for A and B inputs, independently.
SP HI	SETPOINT HIGH	Ranges from -99999 to 999999 with a programmable decimal point.
SP LO	SETPOINT LOW	Ranges from -99999 to 999999 with a programmable decimal point.
t1 Int	P6000 function is TIME INTERVAL A to B	FrEq, PEr1od, Fr brA, totAL
totAL	P6000 function is TOTALIZE	FrEq, PEr1od, t1 Int, Fr brA

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